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REPORT ON RESEARCH AND RELATED SERVICES

IN THE UNITED STATES DEPARTMENT OF AGRICULTURE

Part I

Science Transforms American Agriculture

Prepared at the request of the
House Committee on Agriculture
Special Subcommittee
Honorable Stephen Pace, Chairman

United States Department of Agriculture
Washington, D. C., December 1950

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This report covers research and related services in the U. S. Department of Agriculture. It is impossible to report on research activities of the Department without at the same time discussing work of the land-grant colleges and universities, because such a large share of our research is carried on in cooperation with the agricultural experiment stations. Similarly, most of our educational work is in cooperation with the State extension services. This partnership goes back to 1862. In that year the Federal Congress passed legislation that laid the groundwork for the land-grant colleges and established what is now the Department of Agriculture.

Service activities of the Department have likewise been conducted jointly with the States--in most cases with State departments of agriculture and bureaus of markets.

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Table of Contents

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Washington, D. C.

LETTER OF TRANSMITTAL

December 8, 1950

Hon. Stephen Pace, Chairman
Special Subcommittee
House Committee on Agriculture
House of Representatives

Dear Mr. Pace:

The accompanying report on research, service, and marketing educational work of the Department has been prepared in compliance with your request, growing out of the hearings on Federal agricultural research before the House Committee on Agriculture, in July 1950.

Since Part II of the report is so detailed and voluminous, we have prepared an introduction, designated as Part I. The detailed description of projects, amounting to about 3100 pages, comprises Part II.

In Part I, I have discussed a few highlights, for those readers who will not have the time to read the full report, that illustrate the extremely broad and basic nature of our work and the effect it has had on our agriculture.

Part II is made up of 39 chapters, each covering major commodities, functions, services, or fields of work such as economics, food and nutrition, marketing improvement, and education. This organization has been planned so as to make the information readily accessible to members of Congress, members of RMA advisory committees, and others interested in special segments of our work.

For the most part these activities are reported on the basis of "work projects," the level at which our agencies keep separate financial records and prepare separate annual progress reports. The statements for these work projects give pertinent information on the nature and purpose of the work being carried on, the currently active "line projects" (subdivisions of activity under the work projects), the history and development of the work, the Federal funds (and, in a few instances, State funds) expended, some of the accomplishments, and some additional work needed in the areas covered by the work project.

Some of the project statements are rather technical in spite of our efforts to simplify them. A number of these projects deal with fundamental research, which gives us the foundation for the applied or so-called practical research. Actually, of course, fundamental research is most practical, for it gives us the principles to use in working out applied problems.

The working out of these problems as shown in the project write-ups may appear in some instances to entail duplication of effort. As an example, the Department cooperates with nearly every Southern State in studying the fertilizer requirements for cotton. You will realize, I am sure, that this is not duplication of effort but adaptation of broad principles to the needs of specific areas.

Results are more striking on some projects than others. A development such as hybrid corn comes only once in a long while. Sometimes we have to work for years without any apparent success. And sometimes we find ourselves in blind alleys. Most of our work, however, in one way or another, helps to clarify the problems before us. Once we have a clear understanding, our chances for specific accomplishments are greatly increased.

Sincerely yours,

Administrator

SCIENCE TRANSFORMS AMERICAN AGRICULTURE

Modern science and technology have transformed American agriculture in the space of a lifetime. Agriculture has made more progress in the United States in the last 75 years than in the previous 75 centuries elsewhere in the world. This period of great advancement coincides with the history of research in the U. S. Department of Agriculture and the State agricultural experiment stations.

Although research provided the original impetus for many of the changes in our agriculture, it was accompanied by growth and development of the country as a whole--expansion of agriculture, the upsurge of industry, transportation, and communication. The Extension Service is taking research directly to the farm. Agricultural outlook work and marketing services such as crop reports, official grades and standards, and the market news service, developed jointly with State departments of agriculture, have played vital roles. Research and development work by industry has been indispensable. In fact, all additions to man's knowledge everywhere have contributed directly or indirectly to the transformation of our agriculture.

What has agricultural research meant to an individual farmer, to agriculture as a whole, and to the Nation? These questions lead to fascinating stories of adventure in distant lands and stories of great ideas coming to life in the minds of scientists working in dingy laboratories. In more recent times, the stories concern groups of scientists working as teams on common problems.

To a farmer, research means hybrid corn, disease-resistant crops, better control of insects and weeds. It means chicks and pigs that grow faster with greater efficiency and dairy cows that give more milk and butterfat. It means more intelligent use of his soils and forests and better methods of marketing what he has to sell. In short, it means a better living and a better way of life.

To agriculture as a whole, research means an increase of 45 percent in crop yields in the last 25 years, 20 percent more milk per cow, and an even greater increase in eggs per hen. It means a doubling of over-all efficiency in the last 50 years. In 1900 one farm worker produced enough for himself and 7 others; now he produces enough for himself and 14 others.

To the Nation, agricultural research has meant the saving of lives, assurance of ample food supplies, and better nutrition for everyone.

While studying the cause and control of a cattle fever at the turn of the century, Department scientists discovered that ticks were carriers of the disease. To the average citizen this might seem to be a bit of routine information, but it was much more than that. It was the first positive proof that insects could carry a disease from one animal to another.

This discovery paved the way for later demonstration by medical research that mosquitoes were carriers of yellow fever and malaria. A Department

scientist had already learned how to control mosquitoes by spraying kerosene on ponds and other small bodies of still water. These discoveries made possible the development of agriculture in vast areas throughout the world and saved countless thousands of lives.

Better understanding of food value and modern methods of refrigeration and distribution have greatly improved diets in the United States. Knowledge of the importance of vitamins, proteins, iron, and calcium in the diet has resulted in a shift from high caloric foods to the protective foods such as meat, fruit, vegetables, eggs, and milk. In 1950 we ate 22 percent more dairy products other than butter, 29 percent more eggs, 19 percent more meat, poultry, and fish, and 10 percent more fruit and vegetables than we ate just prior to World War II.

And now let's take a closer look at some of the research that has revolutionized our agriculture. We will select just a few examples from the many stories that are told in detail in Part II of this report.

CROP PRODUCTION RESEARCH

Hybrid corn is undoubtedly the food production story of the century. Increased yields from hybrids are enough to provide an extra 35 pounds of pork for every man, woman, and child in the United States. Translated into dollars, this extra corn is worth enough every year to pay for all the research ever done by the Department of Agriculture.

The story of hybrid corn begins about 100 years ago with Gregor Mendel, an Austrian monk who cross-pollinated garden peas and observed the result (1866). Although his published work gathered dust for a third of a century, it was rediscovered and became the basis of our science of genetics, which dates from about 1900.

Within a few years two plant breeders in widely separated locations in the United States were crossing inbred lines of corn. One was working at the Illinois Experiment Station, the other for a private foundation. Both observed hybrid vigor and saw its implications in increasing yields of corn, although neither was looking for practical results. They were pure scientists, looking for principles rather than practical applications.

For the next few years much time and talent went into research on hybrid corn. It was 1917, however, before its real potentialities were opened up by work at the Connecticut station that resulted in double crosses, the basis of all our present hybrids. Another decade passed before the public heard much about hybrid corn, but plant breeders were busily building inbred lines that would combine well to create hybrids adapted to specific areas. In an effort to speed up progress through exchange of breeding material, 12 States joined with the Department in a cooperative hybrid corn breeding program in 1925. This joint effort did much to bring about the phenomenal spread of hybrid corn across the corn belt.

Like a prairie fire this new kind of corn swept across the central part of the country. In 1933 only one acre of corn out of each thousand in the United States was planted to hybrids. Ten years later, 51 percent of the corn land was planted to hybrids. Since then it has jumped to 77 percent and continues to grow larger, as hybrids are developed for new areas in the South.

Hybrids boost yields by an average of about 30 percent. For the whole country this means three-quarters of a billion extra bushels of corn every year, worth approximately three-quarters of a billion dollars at farm prices.

I cannot move on to the next story without calling attention to two extremely important points about hybrid corn. First, it began with research that was purely theoretical, with no thought of practical application. The other point is that it took many years. We must not assume from this that every basic research problem is going to end up like hybrid corn, but most of our really big developments come from basic research. We must not become so eager for quick results that we are willing to write off a project that does not show definite gains every 12 months. If this had been done 30 years ago, we would not have hybrid corn today.

The magic wand of science has touched many other crops in addition to corn. Breeding of disease-resistant cereal crops over the last 50 years has saved many farms from bankruptcy, assured adequate supplies of a primary food crop to the whole Nation, and enabled us to alleviate hunger in many parts of the world.

Science Saves our Cereals

Stem rust and other diseases took an enormous toll until varieties developed through cooperative research with State agricultural experiment stations came into general use. When scientists learned that the rust organism spent part of its life on certain varieties of barberries, a large-scale campaign was organized to get rid of these plants. This proved to be a herculean task and is still going on.

Our temporary conquest of stem rust has not come easily. It was one of the earliest diseases to demand attention of cereal breeders. Scientists were puzzled to see a variety that had stood up for several years suddenly succumb. New varieties often met the same fate after a few years of successful resistance. For a while it looked as though we were losing ground as fast as we gained it.

One of the essential ingredients of science is ingenuity. It expressed itself in the mind and hands of a young scientist at Minnesota. He demonstrated that there were many races or forms of stem rust and that varieties of wheat or other cereals might be resistant to one race but not to another. This basic discovery explained many failures of the past and set up new guideposts for the future. It complicated the task of wheat breeders immeasurably, because they were fighting not one organism but a host of organisms, all capable of causing stem rust.

Later on it was learned that the rust spores were hybridizing in nature (during the period spent on barberries) at a faster rate than we were able to hybridize wheat and other cereals. This race between man and nature is still going on. We are only a few steps ahead. If we slacken our pace, the gains of a lifetime will quickly disappear and the rusts will take over.

The recurring problem of plant diseases is well illustrated with oats. In Iowa, farmers have had to shift varieties of this crop twice in the last 10 years because of diseases. Fortunately, new varieties were available because of research. Through increased use of these new varieties, Iowa farmers alone have harvested what has amounted to one extra crop of oats since 1940, and the total of this new wealth has added up to more than 100 million dollars. And the benefits have extended over into other oat-growing States.

New races of oat stem rust -- 2, 7, and 8 -- were found over a widespread area this summer (1950), with much damage in many States. These new races were found in the Dakotas, Iowa, Illinois, Missouri, Oklahoma, Texas, Mississippi, and Florida. Present commercial varieties are susceptible to these new races. We have a resistant source of parent material in our breeding nurseries, but it will take time to breed this resistance into commercial varieties.

Help for King Cotton

One of the measures of our progress in research is the casual way in which we speak of juggling chromosomes. We can breed almost any character we want in a plant if we work at it long enough and hard enough. But it was not always so. The idea of breeding plants to resist diseases is only about 50 years old. Selection of seed from superior plants has been practiced for centuries, but the earliest record of systematic selection for resistance to disease began in 1895 on James Island, near Charleston, South Carolina. The work was done by E. L. Rivers, plantation owner, in an effort to develop a strain of cotton resistant to wilt, a soil-borne disease.

Rivers was unable to combine disease resistance with yield and quality, so in 1899 he called on the Department for help. A young Department scientist from Vermont who had never seen a field of cotton was sent. Together these men made history by deliberately planting selected seed on wilt-infested soil and saving plants that survived. From this work several new varieties were eventually developed.

While this work was going on in South Carolina, the same story was unfolding in far-away North Dakota with flax, also beset by wilt disease. In both cases the principle of survival of the fittest was applied by science. This principle is now widely used in all crop-improvement work.

In the intervening years the cotton plant has been the beneficiary of much research. It was redesigned to meet the threat of boll weevils and the requirements of mechanical production, and now a rather major overhauling appears imminent.

Breeders are developing new and vastly different varieties that offer enormous potentialities for cotton to compete with synthetic fibers. They are developing triple hybrids with fiber strength almost double that of present commercial varieties. These triple hybrids aren't ready for release yet, but they are far enough along that several strains are now included in spinning tests. The germ plasm for these promising new cottons was obtained from three sources -- an Asiatic variety, American upland cotton, and a wild species that grows in the mountains of Arizona.

What has been done for wheat and cotton has been duplicated with most of our major crop plants. Thousands of improved varieties have been developed that thrive better under specific conditions. Some are resistant to insects as well as diseases, while others are more tolerant to drought, heat, or cold; some combine many of these qualities. Still other varieties yield better quality food or industrial products.

Plant Hunters Bring 'Em Back Alive

Much of our success in crop improvement can be credited to foreign germ plasm brought back by plant explorers who have combed desert valleys and wind-swept mountain peaks for wild relatives of our principal crops. Almost 200,000 separate lots of plant material have been brought or sent to this country through the plant introduction work begun by Benjamin Franklin long before the Department existed and later made famous by David Fairchild.

In its early stages the principal objective of plant exploration was to find new crops for our expanding agriculture. Emigrants brought the grains, fruits, and vegetables they had known in Europe, and these were supplemented by private and public means. One of the most notable of Department introductions was the soybean. As originally introduced, the soybean would never have made a big hit in the United States, but plant breeders worked it over and made it a cinderella crop. Just in the last few years breeding has increased yields 20 percent and oil content 10 percent. It now ranks fifth among all our crops in acreage.

Many crops threatened with extinction have been saved through plant breeding. New varieties of sugar beets restored that industry in the West when curly top disease seemed a sure winner. Sugarcane brought from the wilds of New Guinea by a Department scientist who braved head-hunters and other dangers of the tropics gave new life to our sugarcane industry, then on its last legs. Bright leaf tobacco in North Carolina and lettuce and cantaloupes in California are additional crops dramatically saved from threats of extinction by ravishing diseases.

Breeding Vim into Vegetables

A few years ago it was not at all unusual to hear farmers complaining that their seed stock of potatoes had "run out". They meant that yields were getting smaller every year. Tomato growers over large areas lost entire crops from wilt, and cabbage growers were in trouble with a disease known as yellows. Nation-wide breeding programs were organized with State and Federal agencies cooperating, and most of the commercial varieties of these and other vegetable crops now in use are an outgrowth of this teamwork.

The lady with the shopping bag who buys America's groceries has influenced our improvement of fruits, vegetables, and other crops. If she likes potatoes with shallow eyes, we develop them for her. If she wants strawberries with a tart flavor, she may have them. Lined up behind the plant breeders are other scientists whose job it is to see that these and other fresh food products are delivered to the retail markets in prime condition. To round out the job, we are now teaching retailers how to care for these foods so that the consumer may get them in their most attractive, nutritious, and appetizing condition.

Science remembers, however, that beauty is only skin deep. Today's foods are bred for the highest possible vitamin and mineral content, consistent with other market qualities. Tests for vitamin C are now routine in many plant breeding laboratories.

Improving farm products and producing them more efficiently has gone hand in hand. Efficient production is a combination of many things, one of which is usually mechanization.

Mechanized Farming

While corn pickers and grain combines as well as many other machines have been perfected by the farm equipment industry, much work has been and is being done by agricultural engineers in public service research in devising requirements and operating principles for mechanizing such crops as cotton, peanuts, tung nuts, sugarcane, sugar beets, tobacco, sweetpotatoes, and many truck crops. Similar work also is being done in such fields as haying, weed control methods, sprayers and dusters, fertilizer placement, and tillage equipment and methods.

Intensive work in cotton mechanization has resulted in such developments as a new spiral brush cotton stripper, practical methods for better use of flame in weeding and thinning cotton, and special equipment for applying anhydrous ammonia. Of special note also are equipment combinations for multiple duties in speeding field operations in this crop, such as a planter-cultivator combination that permits replanting of "skips" in the stand without changing the tractor equipment even up to the final cultivation.

Cotton ginning investigations carried on by the Department have resulted in many improvements in this process. More than 20 public patents have been issued on devices developed by engineers on this work. Some of these are widely used. One of the latest developments is a line-flow lint cleaner that improves the quality of machine-picked cottons from one-third to one-half a grade. Already from 1,200 to 1,500 of these are in use. A green-boll separator now in experimental development removes 90 to 95 percent of the immature bolls from cotton as it is being ginned. Similar studies have speeded machine production and processing of such fibers as flax, sansevieria, and ramie.

Sometimes it is simpler to fit a crop to an existing machine rather than build a new one. Sorghum was made into a dwarf so that it could be harvested with a combine. Soybeans were made to bear their seed pods higher on the stalk for the convenience of the harvester, and sugar beets are being made over into the shape of garden beets so that they will be easier to harvest mechanically. Hundreds of examples could be cited.

Soil and Water Conservation

In spite of the many improvements in methods of crop production our average yields per acre did not increase very much until about 1935. Since then we have had large increases. I am inclined to believe that the major cause for this was that until 1935 soil deterioration was progressing at a rate sufficient to offset all other improvements. Many of the gains since 1935 are due to better varieties and such things as more effective insecticides. However, we are beginning to slow down soil deterioration, and in many cases stop it and start on the upgrade.

We have learned to classify farm land for its most productive use and to adapt these plans to individual farms. Research has made possible the use of all classes of land in the most effective way. We are recognizing the factors that make cultivation of land hazardous, and working out patterns of safe land use. When erosion and other soil deterioration are controlled, our advances in other lines will appear even more striking.

Closely associated with conservation of the soil is the effect of numerous improved tillage and terracing practices that conserve soil moisture. Somewhere along the line our ceiling on crop production is probably going to be set by the amount of water available for crop growth. As we get better varieties of crops and apply other results of research water will become even more important.

We have lots of room for improvement in the conservation of water. We are now losing about one-third of the rain that falls in the humid region through runoff. Efficiency of irrigation in the West is only about 25 percent. But we are making some progress. Stubble mulch culture traps snow for use of crops in the Plains. In some areas of the higher Plains we can save an extra inch of snow moisture by planting shelter belts. Land use practices for many land conditions have been developed that increase infiltration rates and thereby reduce losses of water.

Soil Management

Research on the use of fertilizers and methods of soil management have revealed many facts useful to farmers in aiding nature to make specific soils more productive. Much has been learned about the use of crop rotations, legumes, and green manures for replenishing soil humus and nitrogen; about procedures for determining the nutrient needs of crops; about materials, methods, and machines for meeting these needs efficiently; and about soil management under irrigation and salinity control.

Because techniques based on these findings have been put to use on many farms throughout the country, productivity is on the come-back in many areas where yields were falling off because of declining soil fertility. On hundreds of thousands of farms in the eastern part of the United States the soil is much better today, as a result of good management, than it ever was under natural conditions.

On the other hand, there are still many farms on which soil productivity is on the down grade. For some, improved methods of soil management are available, but not in use. For others, new techniques are still being worked out. For the Nation generally, we have not yet fully reversed the downward trend in soil productivity.

More extensive use is being made of fertilizers and manures in agriculture, and more efficient fertilizers are being developed through public and private research. During the past ten years, farmers in the United States have doubled their use of chemical fertilizers, and they are now applying them in granular, liquid, and gaseous forms. The importance of the minor plant nutrients such as zinc, iron, cobalt, molybdenum, and manganese is becoming more generally understood. When minor element deficiencies show up in various agricultural areas, ways are being devised for correcting them.

Soil management investigations, combined with recommended practices developed from related research, has produced phenomenal increases in corn yields in North Carolina and other southeastern States.

Use of adapted hybrids, thick spacing, and shallow cultivation, coupled with cover crops and heavy applications of nitrogen fertilizer, more than tripled corn yields in experiments in North Carolina. In 49 experiments over a 5-year period, average yields were boosted from 28 to 81 bushels an acre.

Since 1944 when this study was begun, similar experiments have been conducted in all southern States. More than 55,000 farmers have tried the new method and produced yields that average 70 bushels per acre. Average corn yields for all farmers in 7 southeastern States increased 50 percent in 5 years as a result of this research.

Radioactive Tracers

A significant recent development in soils research is the use of radioactive isotopes. Scientists have unlocked a vast storehouse of knowledge about plants by using radioactive isotope tracers to follow the processes by which plants take up the materials of the earth to yield fruits, grains, and fibers.

Radioactive elements give off a radiation as they disintegrate. This radioactivity makes it possible to detect or trace the radio-element wherever it may go in the soil, through the plant and in an animal.

For example, scientists can fertilize a soil with radio-superphosphate, grow clover, feed the clover to a cow and feed a calf on the cow's milk. After being on such a diet for a month, the calf's bones can be analyzed for total and radio-phosphorus. From the data scientists can calculate the amount of phosphorus in the calf's bones that came from the superphosphate put into the soil.

Significant advances in fertilizer technology have been made since the end of World War II by using the radioactive tracer technique. Scientists have learned the phosphorus needs of various plants at different stages of growth and the efficiency of different phosphates. Radioactive isotopes are being used to study other phases of plant physiology such as learning how plant growth regulators change a plant's growth and why they affect some plants but not others.

We are just beginning to learn how to use these new tools in our study of plants and soils. Every new discovery moves us one step nearer to our goal of learning how to make the wisest use of the greatest of all natural resources -- the soil.

Research Aids Our Shrinking Forests

Next to the soil itself, our greatest natural resource is our forests. We waited a long time to become concerned over the exploitation of this source of fabulous wealth. Our grandfathers were busy conquering a continent. Our fathers finally began to take stock of the situation about 50 years ago, and it is only within comparatively recent times that we have put science to work to help us use our forests intelligently.

Early research in forestry reflected the temper of the times. It was concerned chiefly with measuring forest products and estimating volumes of standing timber on a given tract of land. It was used mainly as a tool in the exploitation of our timber, region by region.

The next era was one of awakening, and forest research turned to finding the minimum requirements for keeping our forest lands productive. Experiments in many parts of the country proved that forests can be managed so as to produce annual crops through selective cutting. Small holdings now provide a worth-while supplemental income every year to many farmers.

In some areas, however, millions of acres of forest land have become barren without any hope of natural reproduction, because all seed trees have been destroyed. For these lands, research has found ways to grow young trees in nurseries, transplant them, and make them live. Planting machines have been developed that save up to 50 percent of the usual planting costs.

Besides getting trees to grow on denuded areas, we are also learning how to make them grow faster. Hybrid poplars in Maine are yielding 4 times as much wood per acre as native poplars. A cross between eastern and western white pines is twice as tall as either parent at 7 years of age. Crosses between several species of southern pines are giving hybrids more useful and, in some cases, more vigorous.

Forest Range Management

Much of our forest land is also range land. Almost half the entire continental area of the United States is range land, and this vast empire has suffered from over-use. Research has shown definitely that the ranges respond to good management.

A grazing experiment in Colorado with beef cattle gave annual returns per section of land of $735 for moderate grazing, compared with returns of $484 under heavy grazing. Desert ranges in New Mexico are now producing almost twice as much beef per acre under good management as they did 30 years ago under poor management.

In some areas good management must be supplemented by reseeding, and our experience has been very encouraging. Reseeding on many western ranges has increased the supply of forage from 5 to as much as 20 times. So far, about 8 million acres of private and public range have been reseeded.

Closely related to research on forests and ranges is that on watershed management. This research has contributed to the development of a national policy of soil and water conservation. This policy has already been reflected in legislative recognition of the role of upstream lands and conditions in downstream water and silt troubles and the adoption of Nation-wide programs to remedy these troubles on a watershed basis.

LIVESTOCK RESEARCH

Every man, woman, and child in the United States and countless millions in other parts of the world are the beneficiaries of livestock research. These dividends in human welfare have come about as a byproduct of efforts of the Department to safeguard and improve our domestic livestock.

I have already mentioned the epochal discovery that pointed the way for control of malaria and other diseases carried by mosquitoes. Another scourge of the human race was conquered when Department scientists discovered the new-world hookworm and identified it as the cause of much of the apparent laziness of many people in tropical and sub-tropical climates. Control of this parasite in humans as well as in livestock for the last 25 years has been based directly upon the work of agricultural scientists.

Research has also protected the American people from trichinosis -- a painful and sometimes fatal disease caused by eating raw, or insufficiently cooked or cured pork products. Trichinae, minute parasites that occur in the flesh of hogs, are transmissible to human beings, causing trichinosis. The parasites in pork can be destroyed by heat, by special kinds of freezing, and by certain concentrations of common salt.

These discoveries were important in meat inspection work, because trichinae cannot be detected by any known practical method. Under packinghouse conditions the discoveries have been applied to processed pork products such as frankfurters, sausages, and hams that may be eaten without further cooking. Meat inspection regulations now provide for special processing, under vigilant supervision, of these pork-containing products.

The meat inspection service of the Department operates entirely for the benefit of consumers. Because of this service we in this country can eat meat and meat products with every assurance that they are wholesome. Those who have not traveled abroad do not always appreciate this fact.

As recently as 1910 many people, including doctors and public health officials, regarded pasteurized milk as unsafe for babies. It was believed by many that pasteurizing milk killed all of the lactic acid bacteria in it and allowed the growth of undesirable organisms that produced toxins. In other words, they felt that pasteurization did more harm than good. It took years of painstaking work for a Department bacteriologist to prove that pasteurized milk was safe even for babies and invalids to drink!

When Department veterinarians developed the now famous strain 19 vaccine that protects calves from brucellosis they were working to safeguard our livestock primarily, but indirectly they were working for the alleviation of human suffering. A related form of this disease -- undulant fever -- attacks man, and may be transmitted by drinking raw milk from a cow that has brucellosis. Through cooperative effort of State and Federal governments this disease is gradually being eliminated from our herds of dairy cattle.

DDT was discovered in Europe almost 75 years ago, but its usefulness as our most versatile insecticide was discovered by entomologists of the Department. It has been used in more ways to protect more crops and livestock from insects

than any insecticide ever discovered. But far beyond these values, its use in protecting troops in World War II from flies, mosquitoes, and lice -- and the diseases they transmit -- made it a boon to mankind. Its role as a life saver tends to dwarf its use in protecting crops and livestock.

These examples illustrate the kinship of all branches of science. When we push back the curtain of darkness in any spot, the light of truth illuminates much more than just that spot. It may, and often does, penetrate other dark areas. It may skip across a continent in the process or it may come into sharp focus in an Iowa pig pen.

Conquest of Hog Cholera

Hogs were dying by the thousands in Iowa in 1897, when a young Department scientist spent the summer vainly trying to stem the tide with a serum made from the bacteria thought to be the cause of hog cholera. This epidemic, as others had done, finally spent itself and farmers were able to grow hogs once more.

It was 6 years before there was another disastrous outbreak of hog cholera in the Middle West. In the meantime, the young scientist had gone to school and earned an M. D. degree by night while carrying on his search for the true cause of hog cholera by day. His industry was rewarded with the discovery that hog cholera was caused by a filterable virus, rather than a bacteria. He also discovered that hogs surviving the disease were immune for life.

When he went back to Iowa in 1903, he was armed with more potent weapons. First he found that blood from immune hogs would give temporary immunity to others. But this was too cumbersome; he was looking for a permanent treatment. Then as he watched farmers burying their dead hogs, an idea was born. Why not combine the protective serum with live virus from the blood of a sick hog? It worked, and losses that often mounted as high as $65,000,000 in a single year were reduced to a small fraction of that amount. Use of the serum-virus treatment for immunizing pigs is now standard practice wherever hogs are grown.

Not all of the conquests of science are so dramatic as the saving of millions of hogs from cholera. Others are a result of cool calculation in an effort to satisfy, or even anticipate, demands of consumers. One of these demands has been for less fat and more lean cuts of pork. Export and domestic demand for lard began dropping soon after the first World War, and the depression made matters worse.

This situation presented a challenge to scientists -- a challenge to redesign the American hog, to stretch him out and take off those excess pounds of fat. The first step was to import several animals of the Danish Landrace breed, developed for export to England, where demand calls for lean pork. This breed was crossed with several domestic breeds, both at Beltsville and at several State experiment stations. The objective has been a streamlined hog with less fat and more of his total weight in the choice cuts. In addition, the new hogs must meet all the requirements for efficient production -- large litters of pigs that grow fast. After 16 years 3 strains developed by the States are now in commercial production and 7 more lines developed at Beltsville are now getting their final tests on farms in Pennsylvania.

Farmers like these new hogs and will grow them if they are properly valued in the market. When meat-type hogs first appeared on our markets, buyers discounted their prices because they thought the hogs were not well finished. This called for an educational campaign among buyers and packers, and a revision of official grades for live hogs. There is more to be done along this line, but some buyers are finding that they can recognize the new-type hogs readily and are now paying premiums for them.

Some of the most significant research on breeding of livestock has been done with dairy cattle. This work has covered about 30 years and has established the proved sire system of breeding. This system discards much of the show-ring emphasis on type and conformation of animals and stresses the point that determines the size of the milk check -- production.

Much of the success of the artificial-breeding movement in the last 10 years is due to the availability of proved sires and the opportunities for farmers to breed their cows to these superior bulls. Artificial breeding associations now provide service for more than 10 percent of the Nation's dairy cows. Proved sires plus artificial breeding give every dairyman in the United States opportunities to improve his herd undreamed of only a generation ago.

Tailor-Made Livestock

Earlier in this report I mentioned that science can breed almost any desired character into a plant if given enough time. It is usually more difficult to do this with livestock because of the longer time between generations, lack of sufficient numbers, and other complications. In spite of these limiting factors, however, we have made quite a start in breeding farm animals that are tailor-made for certain conditions and special needs.

A good example is the Columbia sheep, a breed made-to-order for the Intermountain area. It combines the best features of the Lincoln and the Rambouillet in a breed that economically produces more good wool and more meat than any breed available in that area.

I have already told how the meat-type hogs were bred to meet consumer demand. The same is true of the Beltsville small white turkey. It was developed several years ago to meet requirements of modern housewives, who want smaller turkeys to fit smaller refrigerators, smaller ovens, and smaller families. It is now in heavy commercial production, and commands a sizable premium over large sizes.

A more recent request was for good dairy cows that could take the long hot summers of the Gulf Coast region. We went to India for breeding material this time. The Red Sindhi breed was developed there for heat resistance, so we imported several young animals of a strain developed by American missionaries. These have been crossed with Jerseys, and several of the first generation heifers are now on test at Beltsville. It is yet too early for final evaluation, but it has definitely been established that tolerance to heat can be bred into dairy cattle.

Interesting results have been obtained by crossbreeding chickens for special purposes. In recent years sexing young chicks has become standard practice on many poultry farms. For example, when New Hampshire males are crossed with Barred Rock females, all female chicks will be black and males will be black with a white spot on the head.

Reading the Future of Animals

Science is concerned with many aspects of farm animals. One of the most practical is predicting at an early age if the young animal will grow into an efficient milk or meat producer.

We have had remarkable success in predicting the future of dairy heifer calves at Beltsville when they are 4 months old. The degree of mammary gland development at that age is a good index of future production. The method is now being tested on dairy farms, and if it proves to be practical under farm conditions we will be able to weed out poor producers at 4 months of age instead of much later.

Another instance of foretelling the future occurs in beef cattle breeding, in which we are cooperating with 37 States. The idea of proved sires has been borrowed from the dairy cattle breeders, but the conventional way to prove a sire was to kill off his calves when they were about 18 months old and evaluate their carcasses. We now have a better way. Careful records have shown that it is possible to predict the performance of a bull's offspring by using his own vital statistics, and those of his brothers and sisters. Figures used are birth weight, weaning weight, and rate of gain.

Incidentally, the cooperative beef cattle breeding program, which is based upon closed line breeding within the principal beef breeds, is already paying off. Steers from experimental herds reach a market weight of 900 pounds in 15 months -- 3 months sooner than average range cattle. Also it is not uncommon now for bull calves to weigh 100 pounds at birth. Ten years ago 80 pounds would have been considered good.

Studies of young chicks show that they too give indications of future development at an early age. Early development of wing feathers is a good indication of rapid growth, especially important for broilers. Careful examination of day-old chicks reveals whether they will develop feathers quickly or slowly. Weight at 1 month is also a good index of future gains.

The Darkest Place in the World

A famous editor and educator once said the darkest place in the world was the inside of a dairy cow. What he meant, of course, was that we knew far too little about the life processes that take place inside our farm animals. Although we still have a long way to go, we have made some headway in studying farm animals, particularly from the standpoint of nutrition.

Because of the immediate returns in the milk pail, the feeding of dairy cattle has received a great deal of emphasis in research. A seemingly simple discovery many years ago has saved a lot of grief for milk drinkers, most of

whom doubtless never heard of it. The discovery was that feed flavors and odors are transmitted to the milk directly through the body of the cow. As a result of this work, it is an unwritten law on dairy farms to feed directly after milking rather than before or during the milking period.

Grass silage owes its popularity to research. Several years ago a survey showed that summer butter contains 60 percent more vitamin A per pound than butter made in winter, when green feed is less abundant. This stimulated more research on grass silage. Tests at Beltsville have shown that as much as 50 percent of the protein and 90 percent of the carotene in standing green forage may be lost between cutting and feeding. Preservation of forage crops as grass silage or by barn curing saves more of these nutrients.

Feed is a subject near the heart of all poultrymen, for half their expenses go for feed. One of the most important items of the feed bill is protein. Research prior to the last war gave rather exact requirements for protein, minerals, and vitamins, both for growing birds and for layers.

During the war animal byproducts became scarcer and scarcer. More and more soybean meal was substituted in poultry feeds as a cource of protein. This change in poultry rations brought on new troubles. We found that, without animal protein, the hatchability and livability of chicks went down as the level of soybean meal in the hen's diet went up. With animal protein the troubles disappeared.

In the midst of the dilemma, one of our scientists found that these troubles could be overcome by feeding small quantities of dried cow manure to hens whose eggs were to be used for hatching. He concluded that the manure contained a growth substance or unknown vitamin also present in animal byproducts.

Research men at a commercial laboratory who were also working on the problem isolated a new vitamin, B_{12}, which proved to be the elusive unknown. It is now produced commercially in quantities sufficient to supplement soybean meal in poultry feeds. With the new economical feeds supplemented with B_{12}, it is possible to produce 3-pound broilers on about 2 pounds less feed and in 2 weeks less time than is usually required with a more expensive diet in which all the protein comes from animal sources.

This kind of research sells itself, because it is easy to see that it could make the difference between working for pay or just for the fun of it. We have done many other things--far too numerous to mention here--that shed some light on what our editor friend called the darkest place in the world. In all honesty, however, we must admit that the inside of a dairy cow is still a pretty dark place. And the same can be said for the other classes of livestock on our farms.

Research Teams Up With Service

Research is the backbone of most of our service activities that affect livestock. I have pointed out how these team up in the meat inspection work. The same teamwork exists in our other programs.

One of the early tasks assigned to the Department was fighting livestock diseases, some of which are transmissible to man. The first to be conquered was pleuropneumonia of cattle. The dread foot-and-mouth disease has been eradicated six times since the turn of the century. Only during the past year a deadly form of Asiatic Newcastle disease was detected and eradicated before it could spread to our poultry flocks.

Two diseases receiving concentrated attention at present are brucellosis and tuberculosis of cattle. Both have caused heavy economic losses to the livestock industry and both represent a problem in human health. Tuberculosis has been almost eradicated; Less than 1 percent of our cattle now have it. Before the national program of testing and eradication of diseased animals was begun several years ago, it was not unusual for herds, particularly in heavily concentrated dairy areas around our large cities, to show 25 to 40 percent infection.

Progress is being made in eradicating brucellosis, but the fight here is far from finished. Of more than 5 million official blood tests made last year there were slightly more than 3.5 percent reactors. At the close of the year 432 counties in 21 States qualified for modified accredited areas -- less than 1 percent infection. North Carolina and New Hampshire are completely free of the disease.

Another way in which the Department protects the Nation's livestock is to quarantine all animal immigrants -- a kind of Ellis Island for livestock. If animals show symptoms of disease while they are in quarantine, they are not released until they are entirely recovered.

MAN'S WAR ON INSECTS

The endless war between man and insects has been dramatized by many writers, and some have gone so far as to predict that insects will be here long after man is gone. While I take a more hopeful view, I do not for a moment underestimate the strength of our opponent or the severity of the struggle.

Insects have the advantage of numbers. Entomologists estimate that there are more than a million different kinds of insects on the earth, and that the total number would be a figure so large that it wouldn't have any meaning.

Insects multiply with incredible speed, and they have the further advantage of being able to adapt themselves to almost any condition. This accounts for the fact that insects have been present on this planet much longer than man and have seen many forms of life appear and disappear.

Recent events illustrate the adaptability of insects. For a while it seemed that DDT would practically spell the doom of some of the worst actors of the insect world, such as flies and mosquitoes. Now, however, we are finding that both are showing resistance to this amazing insecticide. Actual cases of proved resistance are still relatively few, but they serve as reminders that we must sharpen our wits and our weapons.

Decisive Battles

The record of Department scientists in this war is filled with many victories, some of which at the time seemed almost disastrous to the foe. In the late 90's, for instance, Department entomologists recommended to the public the drainage of swampy areas and use of kerosene on still bodies of water to control mosquitoes. This recommendation was based upon studies of the life history of the major malaria mosquito in this country. These methods are used all over the world, now supplemented by DDT.

Screens for doors and windows and screened porches are taken for granted by most people in this country. However, their value in providing protection from malaria was demonstrated by experiments of the Department less than 30 years ago. Use of screens is now a "must" in all parts of the world where malaria is a health factor.

But not all of our early guns were trained on mosquitoes. First public interest in the control of houseflies was aroused by the Department, and its battle cry "swat the fly" was heard round the world. This campaign, like that on mosquitoes, was backed by facts concerning the life cycle and feeding habits of the enemy.

Experiments prior to 1900 showed that flies breed most extensively in barnyard manure and that proper sanitation would go a long way toward controlling them and the diseases they carry. Later on household and barn sprays came along, followed by aerosols or mist sprays. The aerosol principle became the basis of the famous aerosol bomb used so widely during the last war by our troops and since the war by everyone.

The most decisive battle to date in our war on insects was the development of DDT. It rocked the insect world, and in spite of the fact that some species are slowly developing resistance to it, DDT is by far our most useful weapon against insects. It has completely changed large-scale control methods against flies, mosquitoes, and many other insects.

Mankind's ancient enemy, typhus, can easily be prevented by controlling its carrier, the body louse. DDT does this to perfection. A typhus epidemic raging in Naples, Italy in 1944 was stopped in its tracks by use of DDT.

Strategy of Current Campaigns

We have also won some notable victories over insect enemies of crops and livestock and those that invade our homes. Sometimes we do this by setting one insect against another. Sometimes a simple change in a farm practice will turn the trick. In some cases we can develop crop varieties that have natural resistance to insects. When none of these methods work, we resort to poisons in the form of insecticides.

The first planned use of one insect to control another took place in 1888-89 when a Department entomologist was sent to Australia to find and bring back an insect that would control cottony-cushion scale -- also native to Australia -- then threatening to destroy California's growing citrus industry.

This trip seemed a long-shot gamble, and the Congress refused to appropriate funds for it. The Department's head entomologist at the time was a resourceful administrator, and he arranged to have his man sent over as a delegate to the Melbourne Exposition, for which funds were already available. Needless to say, the entomologist spent little time at the exposition but scouted the by-ways and hedges. His mission was successful, and his work has become a classic of modern science.

The way we outwit the hessian fly by delaying the planting of winter wheat is a good illustration of fighting insects by changing a farm practice. Entomologists thought this one up many years ago, but until that time hessian flies were one of our major pests of wheat, causing losses as high as $100 million dollars in some years. The only thing farmers have to do is to delay planting of wheat in the fall until after the fall egg-laying period of the fly is over.

We are making increasing use of built-in resistance to insects by developing new strains and varieties of plants that insects don't like. Examples are varieties of corn resistant to the corn borer, corn earworm, or chinch bug; wheat resistant to hessian fly; barley resistant to greenbug; sugar beets resistant to leafhoppers; and alfalfa resistant to aphids. Some of these are already available; others are in the process of development by entomologist and plant breeders.

The final plan of action, when we cannot get results from the others, is to use insecticides. I call attention to this because many well-meaning people believe that the Department has gone overboard in recent years on insecticides. The truth is we have gone overboard on all methods of insect control, because we have no other choice.

It is true that we use chemicals more often than other measures, but that's because they're more effective against most insects. We can't work the delayed planting strategy against very many, and breeding for resistance is slow and expensive work. It's true we have been successful in using many predatory or parasitic insects to control certain enemies, but this method won't work across the board.

New Insecticides Turn the Tide

DDT has upset the enemy in so many instances that I could not even list them. It took care of codling moth, the cause of wormy apples; it controls the corn earworm; and it saved the day for cotton growers. It has made possible the control of forest insects that rank right along with fire as plunderers of our shrinking forests. It has worked wonders against many livestock pests that levy a heavy tax on our milk and meat production.

But DDT is only one of many new insecticides. We are testing hundreds all the time. In many cases a combination of two or more of the new chemicals gives better results than either alone. This has been true against many fruit, vegetable, and cotton insects. Combination insecticides that kill the major pests of cotton in one application is the greatest single advance thus far in our war on these pests.

An entirely new approach to cotton insect control was discovered in certain new organic insecticides that kill boll weevil larvae developing inside punctured squares. Plant tissues absorb these and kill the insects developing within the tissues. This is an intriguing idea, and we are following it up. If insecticides could be put in the soil with fertilizer without harmful effects, costs of application would be greatly reduced.

The war on insects is not confined to stockpen, field, or forest, but must be waged on the home grounds and inside the home. Here, too, we have won some notable victories. Home owners and others can now control Japanese beetle grubs by applying a small quantity of a powder to the soil. This powder contains spores of a disease that kills grubs in the soil. A single, simple application lasts indefinitely.

Clothes moths and other household insects have survived all our strategems of the past, but we think we have most of them cornered now with our new weapons. DDT, chlordane, and pyrethrum plus butoxide are new effective weapons against these pests.

Fifth Column Threatens

The insects that we are fighting here on the home front are just a part of our total enemy. There are more species waiting to set foot on our shores than have already landed. These form a fifth column that staggers the imagination. If they got in, they would more than double the tax we now pay to insects, and they might wreck some parts of our agriculture altogether.

Many of the insects that now give us the most trouble are those that have slipped in when no one was looking. They leave behind their natural enemies and settle down. Some more familiar examples are European corn borer, Japanese beetle, Mexican boll weevil, and hessian fly.

The only guard that stands between us and these hordes of pests is a thin line of Federal plant quarantine inspectors. These men are stationed at the principal ports of entry to examine baggage and other articles brought in by travelers. This is a service that goes on 365 days a year, largely unknown to the people whose crops and orchards are being protected.

Dangerous criminals of the insect world are turned back almost every day in the year by these inspectors. These insects come in ships, by rail, auto, and airplane. They come secreted in packages of food, in wrappings of gifts, and especially in baggage. Parcel post packages are another favorite means of infiltration.

This threat from foreign insects is one that we have to live with, but we had better not forget about it. Just a few of these invaders could establish a beachhead that could wreck our future plans of production.

We've been able to drive out foreign insect invaders in a few instances -- the Mediterranean fruit fly and the Parlatoria date scale, and we've prevented or retarded the spread of others, such as the gypsy moth, white-fringed beetle, and pink boll worm. In these latter instances we're still hopeful our entomologists will find ways of eradicating them, just as they may be doing now with the new weapons in use against the gypsy moth in northeastern States.

Friendly Insects Work For Us

The insect world is full of strife, just as is ours. Fortunately for us many insects live on others, recalling the jingle:

> "Big bugs have little bugs upon their backs to bite 'em;
> Little bugs have littler bugs, and so ad infinitum."

Insects also die by the millions from disease. I have already mentioned how we take advantage of predatory and parasitic insects to control pests of fruit, and how we have spread a deadly disease among Japanese beetles. Our search for allies among the insects goes on constantly.

One of our oldest allies is the honeybee. From Biblical days up to a few years ago this little symbol of industry pretty much escaped the ministrations of science. But now we have disturbed its simple life with artificial breeding. We want to control breeding and build up the bees to be better servants of man. We are well along the way, with inbred lines and hybrid bees, somewhat like hybrid corn.

The production of honey is no longer our chief requirement of bees. We want them to pollinate our crops, many of which will bear no seed or fruit unless they are pollinated by insects. Modern agriculture, including some of our modern weed-killers, insecticides, and farming methods has done badly by some of our old friends such as bumble bees that used to pollinate fruit and forage crops.

Honeybees are now in great demand as pollinators. We have just imported some stingless honeybees from Brazil. These are smaller than ours and live in trees like wild bees. We are studying them at several points in the South, where they would be useful in pollinating fruit and forage crops.

UTILIZATION RESEARCH

So far I have pretty largely discussed production research. In the early days of the Department and State stations the main problems were in production. Export markets were good and no one worried about surpluses. It has been only in comparatively recent years that we have been concerned over new outlets.

Utilization research is essential to efficient production and marketing. It is aimed at improving existing foods, fibers, and other farm products, at creating new ones, and at finding uses for farm wastes and residues. Much of this work is done at the four large regional research laboratories, which have been in operation about 10 years.

These laboratories truly exemplify science in action. The tasks assigned to them are nearly always extremely complicated, and many of them require long and involved work of a fundamental nature. Sometimes the job calls for taking an agricultural materialapart, molecule by molecule, and reassembling it to make a new product.

The old notion that chemists could make silk purses out of sows' ears has given way to the idea that they are the people who make nylon out of coal, air, and water. Most of our work is not so startling, but we have had our share of successes.

Penicillin and Streptomycin

Our contribution to commercial production of penicillin contained all the elements of the dramatic and spectacular and was a high spot of wartime research. It was a race with death, depending on how fast science could coax microscopic molds to work.

Our scientists reasoned that somewhere just the "right one" existed. They sought the magic microorganism in every corner of the earth available to us at the time and finally found it in their own back yard -- growing on a spoiled cantaloupe in the Peoria city market. Then it became a question of feeding it just the right diet to make it work at breakneck speed. The fact that the British already knew the value of this wonderful new medicine lent drama and suspense to the race.

Just as brilliant achievements of an individual are often built upon tedious years of study and preparation, so was the penicillin accomplishment based upon many years of experimentation with molds by Department chemists in a search for more efficient ways to convert farm commodities into industrial products. One of the best known examples is the conversion of starch from corn or potatoes into industrial alcohol. The process is also used to produce yeasts, vitamins, and other ingredients of feed.

The penicillin story is only one example of agricultural research that has given us new and useful medicines. Many other antibiotics have emerged from agricultural laboratories. The most famous among these are streptomycin, and its relatives, chloromycetin, aureomycin, and terramycin, discovered at the New Jersey station. Studies of soil microbes led to discovery of these life-saving medicines -- another example of fundamental research that has paid off in a big way.

One of the most notable recent contributions of agricultural research to medical science is the new drug rutin, which is extracted from green buckwheat plants. This drug lessens the severity and duration of bleeding in hemophilia (the so-called bleeding disease of European royalty) and helps to protect people with high blood pressure against apoplexy and retinal hemorrhage. It gives protection from the harmful effects of frost bite and also of X-rays. This has suggested that it may aid in avoiding damage to human tissues from atomic radiation.

Rutin was discovered at one of the regional laboratories when we were looking for something worth-while in low grade tobacco, which was in surplus at the time. The laboratory later found that rutin could be obtained more economically from young buckwheat plants. About 15 pharmaceutical companies are now producing rutin.

Science is not primarily interested in morality. It will provide means of saving life or means to destroy it. Thus the antibiotic story is in sharp contrast with that on guncotton.

During the last war Department chemists hit upon a new method of stabilizing guncotton, or nitrocellulose. The new procedure saves about two-thirds of the time formerly needed in making this explosive. Because it makes possible substantial savings in the cost of smokeless powder for large caliber guns, this process can help cut expenses in rearming our Nation. It also permits powder factories to be smaller and thus less vulnerable to air attack, and easier to move underground if necessary.

Making Cotton More Useful

Cotton has been the subject of much research since establishment of the regional laboratories. This work is laying the foundation for improved cotton goods better able to meet increasing competition from synthetic-fiber products. Research is demonstrating that cotton's natural qualities can be improved by chemical modification of cotton fibers, yarns, and fabrics. Discoveries resulting from this work are now in commercial use.

One of these is a simple dye test that makes it easy for cotton mill operators and cotton dealers to estimate the relative maturity of lint cotton, and thus to find out in advance how it is likely to behave during processing. If lint cotton contains a fairly large proportion of under-developed, thin-walled fibers -- commonly known as "immature" -- it often spins poorly and may cause dyeing defects in the finished goods. The method of detecting immature fibers depends upon the different reactions of mature and immature cotton to a special mixture of red and green dyes, and is now widely used throughout the cotton industry.

Cotton yarn and fabric highly resistant to rot and mildew and able to stand greater heat than ordinary cotton is another recent development. This new cotton looks and feels like the regular product but lasts much longer. It is made by a chemical treatment called partial acetylation and has been adapted for commercial production. Practical tests show this method to be the best so far developed for protecting cotton from rotting and from damage by extended exposure to heat.

Science on the Dining Table

Another important segment of our utilization research deals with foods. Early work of the Department on food adulteration provided the foundation for the pure food and drug laws early in this century. Later work aided the expansion of our food-processing industries and helped to standardize marketing practices among producers and distributors of fruit and vegetable products. Today science is making our foods more appetizing and easier to prepare. We Americans never sit down to eat without having a liberal sprinkling of science in our foods.

Earlier in this report I told how the citrus industry of California was saved by introducing a friendly insect from Australia to stop the ravages of a scale insect that was killing the trees. Many years later the industry was in trouble again -- this time from overproduction -- and again called on the Department and State agencies for help.

The result was a whole array of citrus byproducts, including lemon oil, orange oil, citrate of lime, and citric acid from cull fruit. Pectin, marmalades, and stock feeds joined the list. These items, together with improvements in handling and transporting the fruit to Eastern markets worked out by Department horticulturists, helped to get the industry back on its feet.

Frozen concentrated orange juice offers another example of research coming to the rescue of the citrus industry. Orange growers in Florida were in clover during the war, when the Government was buying large quantities of fruit for processing and shipment overseas, but they were foresighted enough to know this demand would not last. Accordingly, the Florida Citrus Commission and the State experiment station cooperated with the Department to improve frozen citrus juices.

Events proved the wisdom of the Florida growers. Prices dropped below costs of production in the 1946-47 season. As conditions grew worse the chemists again came up with the answer. Frozen concentrated orange juice was an instant success, and is now a familiar item on the breakfast tables of millions of American families every morning.

All concentrate plants are increasing capacity. During the 1950-51 season the 16 plants in Florida expect to produce 35 million gallons of the concentrate. Two plants are being built in Texas, and several are already in operation in California. Value of the Florida pack alone last year was $132 million.

Other food research that is bringing more appetizing foods to our tables -- which I can mention only in passing -- has resulted in frozen orange and lemon purees, fruit essence from apples, grapes, and other fruits, a froth flotation process -- borrowed from the mining industry -- for cleaning peas, and improvements in the processing of pickles.

More About Soybeans

I have already mentioned soybeans as one of our most worth-while introduced plants and told how plant breeders created special varieties for a hundred uses. But even so, the soybean would never have reached its present pinnacle except for research by other scientists in the Department, the States, and in industry that resulted in a wide variety of food and industrial uses. And we are still working on it.

Soybean oil has a tendency to develop undesirable flavor in storage which limits its use for foods. This difficulty is yet to be overcome, but we are making some progress. It has been found, for instance, that a small amount of citric acid, added to soybean oil in the refining process, makes the oil keep three to five times longer. Several commercial refiners are using this method to make better soybean oil for margarine, shortening, and salad dressing.

Department research has added a number of items to the long list of industrial products made from soybeans. The drying quality of soybean oil has been improved for use in paints and varnishes. A whipping material with many of the properties of egg white has been made from soybean protein. A soybean glue now goes into more than half the shotgun shells manufactured in the United States.

New Uses for Agricultural Wastes

The American passion for efficiency is exemplified by our large meat packing houses, where, according to the familiar saying, all of the pig is used except the squeal. Our agriculture has suffered from the lack of such efficiency in controlling waste, but research has not ignored this problem.

For many years the Department has investigated practical ways to use agricultural wastes and residues of various kinds including wheat straw, corncobs, waste vegetable leaves, and the pulps and juices from fruit canning plants.

Our truck farms grow 7 to 8 million tons of a dozen major vegetable crops every year, but less than half of this production reaches the consumer. The remainder consists of leaves, vines, and other materials that are discarded at packing houses and processing plants. Yet many of them are rich in proteins, minerals, vitamins, and other feed nutrients. Practically all of this material goes to waste.

Many other crops contain valuable residues. We have millions of tons of unused wheat straw, corn stalks, and corncobs, for example. By and large, only about half of our farm production in terms of plant material finds worth-while use today. Here is a compelling challenge to research in the future. We have already made a beginning.

Practical methods have been developed for drying waste vegetable leaves and converting them to high-protein leaf meals for livestock. The value of these meals as a good source of protein and carotene has been demonstrated in actual feeding tests.

Substantial advances have been made in the economical utilization of waste fruit and vegetable juices in fermentation processes for production of industrial alcohol, yeasts, vitamins, other feed constituents, and antibiotics. Large quantities of corn steep liquor, a byproduct of the corn refining industry, and milk sugar, a dairy byproduct, are used in the production of penicillin.

Even the lowly corncob is finding a use in industry. It comes back to the farm in the form of nylon stockings for the farmer's wife and daughter.

Several years ago the Department was looking for a way to use corncobs in industry and developed a method for making furfural, a chemical that was selling for about $30 a pound. A few years later, as a result of our work and expanded uses for the chemical, furfural had dropped to 14 cents a pound. Today industry uses 300,000 tons of cobs a year, most of which goes into the manufacture of furfural -- an intermediate used in the production of nylon

Turpentine Farmers Live by Research

To most of us turpentine is something that's used to thin paint or to remove it from our hands or clothing. But to 40,000 farmers in the Southeast, it is a livelihood. These farmers are making a good living out of pine gum, source of gum rosin and turpentine -- long known as naval stores. Most of them carry on other farm operations and work their pine trees as a sideline. No crop in America owes more to research.

Conservation and fire-protection programs have helped immeasurably to maintain and increase the productivity of second-growth pine stands along the South Atlantic and Gulf Coasts. Department researchers have found ways to treat pine trees with an acid spray that stimulates them to increase the flow of gum. Gum processing methods have been radically improved, and the yield and quality of gum turpentine and rosin have been increased.

Modernization of turpentine farming began in the late twenties. Department scientists developed a new gum-distilling process using steam distillation to replace the primitive fire stills that had dotted the piney woods country for 150 years. A few years later a process of gum cleaning lifted most of the rosin from lower grades to the highest, and a method of dehydrating turpentine improved its quality.

These improvements revolutionized the gum naval stores industry. They led to the construction of efficient central distilling plants and made pine gum an ideal "butter and egg crop". Gum can be collected and sold during 9 or 10 months of the year, and if the fish are biting the job can be delayed a few days without loss. A "continuous steam still" is the latest gift of science to this ancient industry.

The Department's naval stores research has contributed to the development of rosin soaps, used commercially on a large scale as emulsifiers in the production of synthetic rubber. Research has also led to effective utilization of other farm products in the manufacture of synthetic rubber.

Besides rosin emulsifiers, fatty-acid soaps from inedible animal fats are also used in large quantities in making synthetic rubber. Technical difficulties threatened the loss of this market for an important agricultural byproduct, so our research men got busy and located the trouble. In this case research served the double purpose of saving a valuable ingredient in our expanding synthetic-rubber industry and the market for an important agricultural byproduct.

Skimming the Cream in Dairy Products Research

From inedible animal fats to tasty dairy products is a pleasant change, but the imprint of research is still there. Our dairy scientists have improved practically every dairy product in existence, and many that we take for granted today are the children of science.

We would not think of eating the kind of butter prevalent in the gay nineties. It was made from unpasteurized sour cream and, in storage, developed odors described as metallic, oily, and fishy. Much of this butter, of course, was a total loss so far as human food was concerned. Scientists of the Department proved that butter of good flavor and keeping quality could be made from pasteurized sweet cream, and the industry adopted the practice.

Our domestic Swiss cheese industry is a result of combining modern science with an ancient art. American cheddar cheese has been vastly improved, chiefly through the use of pasteurized milk. Packaging of cheese in small consumer sizes with transparent wrapping in which the cheese ripens, cuts out the rind loss and has greatly stimulated consumption. Pasteurization has stepped up the output of No. 1 cheese from about 25 to more than 90 percent of total production.

When outbreaks of disease during World War II were traced to the eating of fresh cheese made from raw milk, several States enacted legislation requiring pasteurization of the milk as a substitute for a long ripening period. Enforcement of these laws was greatly helped by a method worked out in our laboratories for checking on pasteurization. The method was later modified for use with practically all dairy products.

When milk is consumed fresh or as evaporated or condensed milk all of the nutrients are utilized. But when it is made into butter or cheese the story is far different. Butter utilizes fat and vitamin A, and cheese utilizes most of the protein and fat and some of the milk sugar and salts. The rest of the vitamins, the minerals, and the milk sugar are left in the skim milk and whey. These products, for the most part, are either inefficiently used or wasted.

This situation has not been ignored by research people, and a good beginning toward making better use of these valuable food nutrients has been made. Dried milks -- both whole and non-fat -- were used widely during and following the last war and are now available in consumer packages.

New good uses for whey have come from our laboratories. A new product, sweetened condensed whey that can be held without refrigeration, was prepared, and formulas for its use have been given to manufacturers of candy, canned soups, and other foods. We can now make excellent ice cream from buttermilk.

Dried milks are now widely used in bread and other foods. Lactic acid is used in making Lactophrene EV, a new synthetic rubber that has higher resistance to heat and oils than any other rubber, natural or synthetic. Casein is used in making a new fiber now used in air filters for automobiles and as a cushioning material in mattresses.

The list of new foods from agricultural research is long and varied. Like the girl in front of the nut shop, I am merely passing out samples of what is being cooked up in our scientific kitchens. We actually did this at a special luncheon for the Agricultural Research Policy Committee at Beltsville some time ago, and some of us were frankly amazed at what we had to offer our guests. Needless to say, the meal was much too big.

One of the primary objectives of utilization research -- and all our other research, for that matter -- is the welfare of our population. This calls for finding out by experiment and then promoting in every way possible the wise use of the foods we produce.

Nutrition for Everyone

Agriculture must supply the kinds and quantities of foods to meet the health needs of all our population. This requires exact information on the nutrients different individuals require in the various age groups. We must also know the foods which supply these nutrients.

Nutrition scientists now measure the amounts of protein required for maintenance and for periods of growth and building up, and they are preparing tables giving the amino acid content of the proteins in important foods. Fats, too, supply certain essential acids. The requirements for these are being studied, and the amounts in food and fat are measured to assure that requirements for health are supplied.

It is hard enough to acquire these basic facts, but sometimes it is even more difficult to get people to use them. While our nutrition workers are getting these facts in the laboratories, others are making surveys to find out what people are buying and eating. For the last 50 years the Department has had an insatiable curiosity about what people eat. This information shows us where we are skating on thin ice and points up the opportunities to improve our diets at no increase in the food budget. Sometimes it even shows how we could save money in the process of choosing foods wisely.

Changing people's food habits is a large order, but we already have ample proof that it can be done. Earlier I mentioned some of the changes in consumption since 1939. Schools are doing the job -- the place where it does the most good -- and home demonstration agents and youth groups are helping. Publications of every description, from the most technical to the most popular, have been issued by the Department and distributed by the millions. As a result of educational campaigns nearly everybody today knows about the "basic 7" foods, about the value of milk and the other protective foods, and about the need for a good breakfast every day in the week.

A good lunch is also a good idea, particularly for school children. Our food preparation scientists have teamed up with the plentiful foods program of the Department and worked up recipes for school lunch use. Recipes for 25, 50, or 100 servings have been prepared, using such foods as potatoes, non-fat dry milk, dried whole eggs, dried fruit, and turkey. This work teaches and demonstrates good nutrition at one and the same time and helps to make use of foods often in surplus supply.

Nutrition is just one part of home economics. Others include studies of clothing and textiles, home equipment, and houses designed for more efficient and convenient living and working.

Clothes for the Working Woman

Clothing scientists have pioneered in designing women's clothing suited to farm work, indoors and out, and to factory jobs. These designs for dresses, coveralls, raincoats, and other garments provide for comfort, freedom in work activities, and safety. When the first designs appeared they set a standard for a new large branch of the work clothes industry. In a few months about 100 companies were putting out garments following the Beltsville designs or making use of the functional principles illustrated.

Practical aid to the clothing industry and better fitting garments for the consumers are resulting from an unusual Department study made a few years ago. It is said that at least $13 million worth of children's clothing is returned annually to retail stores because of inadequate sizing and marking systems. Scientific measurements of 150,000 children and 30,000 women were made, and improved systems for sizing garments were worked out. This work has eliminated much waste due to misfits.

Every family that uses modern household equipment benefits from our work in this field. We maintain a well-equipped laboratory at Beltsville for testing the performance of home freezers, refrigerators, washers, and similar items. Arrangements are made with manufacturers to send in samples of their products, and we give them a thorough going-over and submit a confidential report, making suggestions on how the equipment can be improved. Many of these suggestions are built into the next model.

The Story of A Ladder

The science of wood utilization hit the front pages of every newspaper in the country several years ago in connection with the most famous and sensational kidnapping case in our history. Officials were baffled; their chief clue was a short ladder, but to ordinary crime-detection experts ladders made of wood do not tell their secrets.

Someone thought of Department scientists at the Forest Products Laboratory and asked for a wood expert. Like a bloodhound he traced the lumber from the ladder back to the lumber yard and on back to the purchaser. With this guiding information, nabbing the criminal and convicting him was made possible.

To many newspaper readers the Forest Products Laboratory was an unknown quantity, but not to thousands of wood and lumber users. They had been taking their problems to the laboratory for many years.

The newspapers themselves and their readers owe quite a debt to the science of forestry. Forty years ago spruce pulpwood furnished most of our paper, with some help from balsam, hemlock, and poplar. Scientists found ways to use some of the more plentiful species, such as the southern pine, Douglas fir, and many of the hardwoods. Yields have also been increased.

One of the interesting stories of wood concerns the rather simple thing of fastening together two or more pieces of timber. First we used wooden pegs, then metal drift pins, nails, bolts, and finally modern metal connectors that make it possible to design wooden structures with engineering precision. The laminating of beams, arches, and other structural members has been brought to a high state of development to provide a means of making small pieces do the work of large timbers, as the large trees of our virgin forests disappear.

Plywood has been transformed from a whimsical product whose behavior was unpredictable into a dependable material that can be used for exterior building purposes.

We have learned much about wood chemistry. Cellulose can now be changed to sugar and it in turn to ethyl alcohol, feed yeast, molasses, or other products. Lignin is a potential source of alcohols and many other chemicals.

More than a million tests have been made at the laboratory to get exact information on the properties of 175 native woods and materials derived from wood. With modern glues developed by research the glueing of wood has progressed from a traditional and secretive process into a well-established commercial operation free of trade secrets and hocus-pocus.

Seasoning of lumber has been changed from a slow process dependent upon nature for heat and air circulation to a highly specialized scientific process. Wood preservation treatments have been vastly improved and are in wide use now. Other treatments prevent swelling and shrinking, and still others can make soft woods behave like hardwood.

ECONOMIC RESEARCH FOR FARMERS

Farming today is a business that requires high-class economic counsel based on the most reliable data that can be brought together. Efforts to provide this began more than a century ago with Federal collection of a few statistics on farm production. Today economic research on the organization and operation of farms and on the impact upon farmers of technological progress, of changing supply and demand conditions, of varied developments throughout the domestic and world economies has become a major activity both in the Department and in the land-grant colleges.

Economics of Production

Each new machine, each new practice that comes from laboratory or field plot poses new questions for the dirt farmer. He needs to know, "Will it pay? How can I change my farming operations to make it pay?" Combining the separate contributions of research on plants, animals, and machines into efficient and profitable systems of farming is a never-ending task in this age of rapid technological advance.

Farm Budget Analysis has been developed into an effective farm management research tool for dealing with this problem. Today in some of the State experiment stations the most promising combinations of crops and livestock developed through farm budgets are being tested on farm-scale research farms. On these farms the results of many unrelated lines of research are being fitted together into farm plans that will work, area by area. This synthesizing of the work of the natural scientist and the engineer with that of the economist is still in its infancy. I am confident that it holds great promise for hastening the application of research results on farms throughout the Nation.

The value of research in farm organization and management was dramatized in World War II. It furnished the basis for much of our program for mobilizing agricultural production. We had to have information on needed acreage of crops, numbers of livestock, size of labor force, amounts of machinery, gasoline, and other items. The Department was able to furnish this information

With the cooperation of the land-grant colleges, the productive capacity of agriculture was analyzed as a basis for yearly production goals to meet the Nation's wartime needs. Many farmers were asked to make drastic changes in their operations. Economic research helped them plan these adjustments efficiently and indicated the prices and other inducements necessary to encourage ventures into new lines of production.

Not all production problems can be resolved by farmers acting as individuals. Conservation and utilization of land and water resources, land tenure and land values, zoning, agricultural credit, insurance and taxation all present economic problems of broader implication. Federal and State research has contributed to improvements in farm leasing systems, to putting farmers' mutual insurance on a sound basis, to a better understanding of the farm mortgage situation. National programs for specialized farm credit, for crop insurance, for encouraging sound conservation measures are built on the foundation stones of research in these fields.

Economic Advisory Service to Farmers

Agriculture today is one of several major industries in a close-knit economy. Both farmers' individual success and the National well-being depend heavily on the ability of farmers to adjust their business in the light of a multiplicity of economic developments.

Thanks to agricultural economics research, farmers faced with this need have an economic advisory service which is today on a par with that available to any segment of industry. Starting with the first annual Outlook Conference, in 1923, this work has expanded into a year-round service providing current information on supply, demand, price, and other trends for every major group of agricultural commodities.

Information on significant developments, both at home and throughout the world, is continuously assembled and analyzed by agencies of the Department. Results of this research are rapidly disseminated, through the periodic Situation and other reports, to economists and extension specialists in the States, to the farm press, and to farm leaders and advisers throughout the country. They adapt this information to local conditions or problems so it will be most useful to individual farmers.

Measuring the Economic Situation of Farmers

Scientific analysis of any problem depends first of all upon identification and measurement of many factors. In economics, this requires the combination of statistical data into workable form. Our success in this constitutes a major achievement in agricultural research.

The indexes of prices received and of prices paid by farmers are early fruits of research ingenuity in tackling this problem. These indexes made possible the concrete formulation of the "parity" goal for agriculture as embodied in our basic farm policy legislation. Other index numbers provide composite measures of crop yields and farm production, of total and average per capita food and fiber consumption, of the farmer's share of the consumer's dollar, of farm costs and returns, of farm employment and wage rates, of farm land values--indeed of virtually all the economic factors significant for appraising the situation of agriculture as a whole and of its many segments.

"Farm population" has been meaningfully defined for use in the Decennial Census, and measures of farm family levels of living have been devised for comparison between areas and with other population groups. Systems have been developed for economic classification of farms and type-of-farming areas, and the financial condition of farming as a whole has been uniquely portrayed in the annual "Balance Sheet of Agriculture."

For no other segment of the economy do we have so adequate and so effectively organized a body of statistical measures of economic conditions as we do for American agriculture. They form an outstanding and essential part of our National economic statistics. They are the foundation for appraising current economic developments. They provide the basis for determining the farm adjustments which are needed, either in war or in peace, to most effectively meet our consumption and foreign trade needs.

These varied services of agricultural economics research have come to be largely taken for granted by the farmers, business men, and agricultural leaders who rely upon them for information and guidance. They have become the accepted basis of fact for policy formulation both by Congressmen in the enactment of legislation and by Executive Branch officials in program administration. They play their role, in partnership with research in the natural sciences, in the continuing progress of American agriculture toward the twin goals of greater productivity and higher levels of living for agricultural producers and of more abundant supplies of farm products to meet the Nation's expanding needs.

MARKETING RESEARCH AND SERVICES

In my discussion on production and utilization I have called attention to many instances of research that were prompted by changing conditions in the marketing of farm products. My purpose has been to show that no branch of agricultural research can be carried on intelligently without considering the others. Marketing requires more than the usual consideration, for it influences our other research in so many ways.

Plant breeders wouldn't think of introducing a new variety of wheat without making sure of its milling and baking quality. New food products developed in the laboratories don't get very far unless they have that certain something that makes people willing and eager to buy them. In a highly developed agriculture such as ours, the marketing process demands the best talent we have for research, service, and educational work.

In the Department and at the State stations marketing research has lagged far behind that on production. This situation led to the passage of the Research and Marketing Act in 1946, which gave special emphasis to marketing research, service, and education. We now have a very broad program of work going on under this Act, and I intend to cite several examples of progress. Before doing this, however, it might be well to take a quick look at marketing research and services that have been going on for many years and which have played a major role in bringing our agriculture to its present stage of development.

As long as farmers grew everything they needed and their wives made everything the family used, there was no marketing problem in American agriculture, and hence no need for marketing research or services. With the expansion of agriculture and specialized production of crops and livestock, farmers became aware of the marketing process.

The railroads did much to sharpen this awareness. Farm products began to travel long distances to big cities, and buying and selling were no longer a face-to-face transaction between neighbors. Farmers, often in debt, rushed their produce to market at harvest time, causing oversupplies and ruinous prices. Wide spreads in prices received by farmers and those in retail stores convinced farmers that they were not getting fair treatment. Farmers blamed the middleman and demanded action from State and Federal Governments.

Consumers also were demanding action by the Government. Unsanitary handling of meat in the packing houses, dramatized in Upton Sinclair's book, "The Jungle," led to the Federal Meat Inspection Service. Other abuses in the commercial handling and preparation of foods led to the passage of the pure food laws in 1906, administered for many years by the Department.

In the decade between 1914 and 1924 the Congress responded to the demands of farmers with several sweeping actions that helped to put farmers in a better position to deal intelligently in the market place. One of the first of these was the Market News Service, created in 1915.

Market News Reaches Every Farmer

If the value of a Department service were to be measured by the space it receives in the daily press or by the amount of time it gets on the air, market reports would be in the number one position. These reports are now carried by some 1200 daily newspapers and close to 1400 radio stations, not as a service to the Department but to readers and listeners. Although market reports of one kind or another are available to every farmer in the United States, either at the mail box or at the kitchen radio, there are still commodities and markets on which farmers need more information.

Of course, it was not like this at first. In the first few years the reports were issued at a few of the larger cities and covered only fruits and vegetables. Since then the service has been expanded to cover all major farm products. As an economy measure, the Department was told to abolish the service on July 1, 1933. Notices went out only about a week prior to this date, but during that week an avalanche of letters, telegrams, and telephone calls left no doubt of the value of this service to the trade as well as to farmers. As a result, the service was continued.

There is a story in the Department that an official sensed the need of a market news service 10 years before its creation and figured out a plan for its operation. However, when he estimated the cost, including a leased wire network--very much as we have it today--he discovered that it would cost almost a million dollars a year to operate such a service. He concluded that it would be impossible to get that much money, and the idea was dropped. Events later proved that his idea was not only practical but a necessity of modern agriculture.

Selling Farm Products by Grade

The market news service could never have amounted to much without uniform grades and standards for farm products. Fortunately the two services developed concurrently. It wouldn't have meant much to a farmer or to elevator operators to know that wheat was bringing from $1.50 to $2.00 a bushel unless all parties knew what kind of wheat was bringing each price.

Passage of the Cotton Futures Act in 1914, requiring the use of Federal standards in trading in cotton futures, definitely established the Department in standardization work. Grades of a sort were in use as far back as 1825 in New Orleans, but the grade names were not tied down to a fixed standard. The need for uniformity was voiced by growers and domestic spinners, as well as by cotton merchants and exporters.

Confusion in the cotton trade was no worse than that in grain. In 1906 there were 133 grades for wheat, 63 for corn, and so on down the line. Some States had their own official grades. Boards of Trade in the large grain centers also had their own grades for grain, and very few of these agreed with one another. Buying a pig in a poke was a relatively safe transaction compared with buying or selling grain.

This situation was corrected by the Grain Standards Act of 1916. Other commodities were covered by later legislation, and now we have official grades for practically all agricultural products. Their use has spread from the wholesale markets to the retail field, where butter, eggs, turkeys, rice, dry beans, potatoes, canned fruit and vegetables, and other commodities are

being sold on the basis of grades. From the beginning, much of this work has been carried on in cooperation with State departments of agriculture and bureaus of markets.

Other important legislation of 1916 included the Warehouse Act, which made it possible for farmers to store staple commodities while safely waiting for a more favorable market. In effect, warehouse receipts proved to be a very useful form of credit for farmers and marketing agencies, as they could borrow money on these receipts.

Inspection of farm products by Federal-State inspectors, another big step in developing our marketing system, was authorized in 1917. This gave farmers an impartial referee and put a stop to many abuses. This work also plays an important part in settling disputes among shippers, carriers, and buyers in the big cities. Inspection also is an essential feature of price support programs and marketing agreements.

Legislation Corrects Abuses

Another chapter in the history of marketing was written in 1921 with the passage of the Packers and Stockyards Act. This legislation recognized public stockyards as a public utility, subject to public regulation by the Secretary of Agriculture.

Still another landmark came in 1922 with passage of the Grain Futures Act, which gave authority to the Secretary of Agriculture to regulate trading in grain futures. This was a response to the long-standing suspicion among farmers that trading in futures was just another way of driving down the prices of their products so that big profits could be made by professional traders. This and other similar legislation was incorporated into the Commodity Exchange Act as amended in 1936.

The Produce Agency Act of 1927 and the Perishable Agricultural Commodities Act of 1930 were among later developments that broadened the protection to farmers and incidentally helped the reliable dealers. These acts required buyers and commission men to show financial responsibility and to accept obligations to fulfill contracts.

These regulatory acts represented profound changes in our way of life, and I do not want my brief treatment of them to suggest that they were as simple as adopting a new type of cultivator or a new breed of livestock. Extremists on both sides were dissatisfied when these laws were passed: those on one hand cried out against Government interference, while those on the other side demanded that the Government more strictly control buying and selling of farm products.

Mounting surpluses and falling prices for farm products in the twenties brought forth many proposals for giving relief to farmers. Prominent among these was a call for an expansion of marketing services and regulatory authority of the Government. We have seen how many of these proposals were put into effect. The market news service was strengthened, standardization was broadened, and commodity futures markets were regulated. The Department began its economic outlook programs to guide farmers in planning production and marketing. This was the first of many subsequent efforts to help farmers adjust production to effective demand.

Crop Reports Keep Farmers Posted

Basic to all Government services to farmers are the crop and livestock estimates of the Department. This is by far the oldest of our economic services, beginning in 1839 with the first appropriation ever made by the Federal Government for agriculture. Collection of agriculturl statistics was one of the two major lines of work specified in the first appropriation. However, only a few annual crop estimates were issued from 1841 to 1845 and then stopped.

Beginning in 1863 the Commissioner of Agriculture published monthly reports on the condition of crops. The reporting force during this period was a Nation-wide voluntary group of county crop reporters. In 1866 annual reports on acreage, yields, and production of important crops and livestock numbers were begun.

As the service developed, estimates of production became a regular part of it. By 1920 production estimates were made for 29 crops and for wool. Condition reports were issued for 44 crops. A continual research program has been conducted in recent years in an effort to improve the estimates. In fact, the modern science of statistical sampling and forecasting had its origin in the work done by the Crop Reporting Board.

In the present comprehensive program, crop, livestock, and price estimates currently released in some 500 reports each year lend themselves to a wide array of practical uses by farmers and dealers in farm products. Their current usefulness is heightened by the fact that a broad background of continuing series of data on agricultural production now covers a span of 85 years.

It would be hard to imagine the condition of our agriculture today without these marketing services. Certainly the technological revolution brought about by research in production could not have progressed as it has without benefit of similar, though less spectacular developments in marketing. Farmers try out new practices such as chemical weed killers, for example, when they have sufficient funds to make the investments that are often necessary. Without the additional income provided by improvements in the marketing process, I fear that many of our improvements in production might still be waiting for adoption by farmers.

Valuable as these marketing services have been, each new emergency, each new farm production and marketing problem turned the spotlight on the need for more marketing research. When the Research and Marketing Act was passed in 1946 only 4 percent of the Department's budget for research was being spent on what might be considered strictly marketing research. This does not take into account the basic economic research, much of which is fundamental to all applied research in marketing. Neither does it take into account the large volume of production and utilization research, already referred to, that owes its existence to changes in consumer demand. But even with these explanations, it does show that marketing research was lagging and why the RMA gave so much prominence to marketing.

RMA A Landmark in Agricultural Legislation

The Research and Marketing Act will be cited by historians as a landmark in agricultural legislation. Since I have discussed the over-all policy considerations that guide us in administering this Act and the work of advisory committees in the RMA annual reports for 1949 and 1950, I will not take the time here to repeat what I said in those two reports. Instead, I want to tell some of the stories that have developed from just 4 years of work under this Act, and show how it has greatly strengthened our marketing work in all its phases. Some of these stories are nowhere near complete, but the first few chapters on some of them suggest interesting endings.

One of these stories is about prolonging the useful life of fresh fruit and vegetables in retail markets. It is pretty generally known that in recent years marketing costs have eaten up about half of each dollar consumers spend for food. The most costly step in the marketing process is the retail sale. The widest margins taken in retailing are traditionally in the handling of fresh fruits and vegetables. Improvements in handling by producer and wholesaler have often not been reflected in the retailing of foodstuffs. We therefore directed one of the earliest RMA studies to this situation. Part of the job was to determine the merits of retailer training courses as a means of getting modern and efficient methods more widely applied.

Industry had recognized the same problem and was making efforts to correct it, but neither facilities nor funds were adequate. Because of this background we decided that the most practical approach would be through a contract with a fruit and vegetable trade association that already had experience in this field.

Under contract, more than 2,000 training classes have been held at more than 100 locations, and approximately 20,000 dealers and their employees have taken the 1-day course in better methods of handling and displaying fruits and vegetables. So far we have reached only a small percentage of the retailers, but the wide publicity givento this work is spreading its influence far beyond those reached in the classes.

Effectiveness of this training course is shown by a survey of those who took it. More than 95 percent reported that adoption of the improved practices increased sales and reduced losses. Over 45 percent of the retailers who took the course renovated or remodeled their produce departments, and some went so far as to remodel their entire stores.

Nearly all the retailers adopted the recommended practices in trimming produce, in planning displays so as to take advantage of pleasing color contrasts, and in watering produce on display. Many other practices developed through research are being taught in the training schools and applied in the stores. In this way we expect to take a big slice off the $300 million loss that retailers have to absorb annually because of spoilage and waste in fresh produce.

Improving Market Facilities

But the retail markets have no monopoly on waste and inefficiencies. Some of the large terminal markets in the big cities also have their share. Many of these market facilities were built 100 years ago, and it is not surprising that they do not fit today's concepts of efficiency. They operate with

horse and buggy efficiency in a jet propulsion age.

This problem was brought into focus by research in the thirties, and a beginning was made on it. Our work is primarily an advisory service on planning the location, design, and operation of markets for fruits, vegetables, poultry, meats, and other foods.

Our marketing specialists study the needs in a given city and prepare a detailed report, which amounts to a complete blueprint for building, financing, and operating a market. The plan explains what kinds and sizes of facilities are needed, the best locations for them, what they would cost, how they would be financed, how they should be managed and operated, what the savings over present facilities would be, and an estimate of benefits to farmers, distributors, consumers, and the community at large. In accordance with these plans, new and modern markets have been built in several cities. One of these markets doubled its business in one year and had to increase its facilities again. Estimated savings for just one large market are $4 million a year.

Requests for these plans come in faster than we can take care of them.

Application of engineering methods to increase efficiency is likewise being extended to packing plants, warehouses, processing plants, and even wholesale and retail stores. Ben Franklin's adage about taking care of the pennies is illustrated in a new check-out counter developed by the Department for retail grocery stores.

The usual check-out procedure in grocery stores takes care of about 32 customers an hour. Using the new counter, eliminating some operations, and combining others, it is possible to take care of 44 customers per hour. This is an increase of 38 percent in moving customers through the check-out bottleneck.

This speed-up results in a worth-while reduction in labor costs, but even more important is the increased volume of business made possible. The new counter is covered by a public service patent, which makes it available to all stores, whether chain or independent. As it comes into wider use, it and other improvements in efficiency should result in reducing the spread between the price the farmer gets and that paid by the consumers.

Another story deals with eggs. Americans like eggs for breakfast, and they like them fresh. All eggs rate top quality when laid, but unfortunately many are beginning to show signs of age by the time they reach the breakfast table. The reason for this is the long journey from the farmer's gate to the city housewife's frying pan.

A study of egg marketing in the 12 North Central States and Kentucky has given exact information as to where the trouble lies. One-third of the eggs were below grade A in quality when delivered by producers. Between the country buying point and the carlot assembly plant, 1 egg out of 8 dropped to a lower grade. This fact and others brought out in the study emphasize the need for starting eggs to market at top quality, moving them faster, keeping them cool, and following other practices that maintain quality.

Finding Out What People Want

Sometimes our marketing research takes us to the farms or to country shipping points, as did the egg study. Other studies take us to city consumers, where scientifically selected groups are interviewed to find out what preferences and prejudices they have. Where do they buy? What do they buy? Why do they buy it? Such information is useful not only to farmers, but to processors, retailers, and others interested in getting farm products used.

A recent study of this type was concerned with how people make up their minds in deciding between different grades of wool in men's suits, coats, and jackets. The findings were of such practical value that the wool industry used them in an educational campaign. Other consumer-preference studies likewise have given useful and practical information.

It is one thing to find out what people want, but sometimes it is quite another matter to provide it for them. We know that consumers want their fresh fruits and vegetables in farm-fresh condition. I have already pointed out how eggs deteriorate in the journey from farm to market. The same thing happens to many fruits and vegetables unless we keep on the job.

Research on these crops in storage and on their way to market has taught us many ways to reduce losses and deliver an appetizing and nutritious product. The scald disease of apples, for example, was a costly plague to growers until science discovered that by wrapping apples in paper treated with odorless and tasteless mineral oil, or by packing them in such paper in shredded form, the disease could be prevented.

Marketing costs for California orange growers have been greatly reduced by similar research. For years shipping regulations required the air vents of refrigerator cars to be closed as soon as the outside temperature reached 32 degrees F. Under these conditions cars loaded with warm oranges had to be iced to prevent spoilage. Scientists found that icing was unnecessary during winter months if the air vents were left open while the trains passed over cool western mountains. Shipping regulations were revised, and the growers and consumers pocket the ice money.

Related research that is helping to reduce waste and inefficiency in marketing is concerned with shipping crates that carry produce with the least damage in transit, with loading methods that reduce breakage, with precooling and other practices that maintain quality, and with methods of packing and handling fresh produce. A new type of crate developed for shipping lettuce and carrots, for example, is expected to save a large sum each year in refrigeration and loading costs alone, with additional savings through reduced damage to the produce during shipment.

Who Gets the Consumer's Dollar?

Earlier in this report I spoke of the concern among farmers over the spread between the prices they got for their products and those the city consumer had to pay. This concern goes back at least a century and has been the subject of Congressional interest and inquiry on many occasions.

Previous to the passage of the Research and Marketing Act, the Department made many studies of price spreads between producer and consumer and had published this information widely. However, relatively little was done toward measuring the cost of specific marketing functions such as wholesaling, transportation, processing, and retailing. This type of research has been stressed since RMA funds became available, and several reports have already been published.

Most of these studies are still in the preliminary stages, but substantial progress has been made toward determining the margins between cost and selling prices on bread and flour, apples, oranges, tomatoes, potatoes, eggs, broilers, meat, milk, cotton products, and tobacco products. A beginning has been made in determining the costs incurred by handlers and service agencies in marketing farm products.

This research differs from much now going on in the Department in that we can present the facts but we have no machinery for correcting unsatisfactory conditions. Nevertheless, it seems obvious to me that this whole area is one that needs exploration, and the first thing to do is get the facts. That is what we are doing. I feel sure that any glaring inefficiencies brought to light by these studies will be corrected by industry. Where they are not, we may assume that Congressional interest will find a way to express itself. However, we must keep in mind that consumers are demanding and getting more and more services. These services cost money, and account in some measure for a shrinkage of the percentage of the consumer's dollar received by farmers.

Cooperation With State Departments of Agriculture

Although much of our long-time marketing service work has been done in cooperation with State Departments of Agriculture, a new type of Federal-State marketing service work came into being with enactment of the Research and Marketing Act of 1946. This work constitutes a program under which State Departments of Agriculture, with the cooperation of the Department, attack the major agricultural marketing service problems, of whatever nature, that confront the particular States.

The work has been divided into three broad categories: (1) Expanding market outlets for farm products through provision of special market information, such as data on local supplies and on markets where they can be sold to advantage; (2) improving and expanding market information -- basic data on supplies and quality of crops, grading, and other marketing services; and (3) assistance to marketing agencies, such as local markets, cooperatives, and similar organizations, in improving their operating efficiency.

Work in this program is highly varied. A few examples will indicate its scope.

One of the Southern States found that the quality of its cotton was suffering from defective ginning. A State specialist visited numerous cotton gins, suggested improvements in machinery and practices, and aided in the selection of new equipment. Rough preparation of cotton in cooperating gins was reduced from 19 percent in 1947 to 4½ percent in 1948, increasing the value of the cotton by more than $2 a bale.

Producers of tomatoes in another area habitually brought their crop to market ungraded in field crates and received relatively low prices. Marketing specialists advised the growers to prepare a high-quality pack and showed them how to grade the tomatoes. Within a matter of days, the idea took hold, and prices for the crop rose sharply, in proportion to the improvement in quality and handling.

A Wheat State makes annual pre-harvest surveys, by counties, of the quantities and qualities of the grain to be harvested. These surveys provide guidance to growers as to the prices they should receive and to buyers as to the areas where they can find the kinds and qualities of grain they want.

Counts of fruit trees, by age groups, have been made in some States, to indicate the probable crop in future years as a guide to the best planting, production, and marketing practices. Growers of various kinds of berries, small fruits, and vegetables have been assisted in adopting proper grading and packing methods to preserve the quality of their crops and to meet the desires of consumers.

Helping Farmers to Cooperate

Our story of what research has done and is doing to improve marketing would not be complete without some mention of cooperative marketing. The Department began work in this field in the early years of the century in connection with studies designed to improve the efficiency of fruit marketing. The first formal research project -- cooperative handling and marketing of cotton -- was begun in 1912.

When the Office of Markets was established in 1913, one of its principal responsibilities was to assist farmers in developing efficient cooperative associations. With the rapid growth of cooperatives after World War I, the demand for such assistance was recognized in various research studies. In 1926 Congress further recognized the importance of this trend by passing the Cooperative Marketing Act which set up a special division to promote research and technical service for marketing and purchasing cooperatives.

Many of the early co-ops failed because of shaky legal and fiscal foundations. Department research helped in both these fields. Some groups were advised how to proceed; others were advised not to proceed at all. Many of the young co-ops were having trouble with accounting procedures, and we were able to give them the kind of help they needed.

Many years ago some of the cooperatives figured that if farmers benefit from working together in a small co-op, that groups of small co-ops should also benefit from a similar banding together. Because of its wide experience, the Department has been able to help in this movement. There are now many strong federations of local cooperatives.

Further coordination of marketing by local cooperatives still is necessary in order to bring about the standardization of products, increased volume, more effective salesmanship and sales promotion, and to reduce marketing costs. Part of the current work with dairy, fruit and vegetable and livestock co-ops is directed toward this problem.

Current emphasis is being directed toward increasing efficiency of operations through operating economies in the marketing and distribution of feed, packing and processing of citrus fruits, operation of farmers' elevators and cotton gins, and marketing of poultry and eggs. An indication of the possibilities in this direction appears in the work with citrus, where it now seems likely that costs of harvesting may be reduced as much as $2 million a year through developing facilities for handling the fruit in bulk rather than in field boxes.

Department research in cooperative purchasing has been closely related to that in cooperative marketing because effective procurement of supplies is essential to efficient production and marketing. In fact, many farmers' cooperatives engage in both activities. Studies of cooperative purchasing date back to 1912, but their importance has greatly increased as the bill for such farm supplies as feed, petroleum, fertilizer, insecticides, farm equipment, farm machinery, containers and other packaging material has increased with the mechanization and commercialization of agriculture.

Educational Work in Marketing

Since its creation in 1914 the Extension Service has been the educational arm of the Department, and the State extension services have carried on the out-of-school educational work of the land-grant colleges. When this work began, the emphasis was almost entirely on production for the very good reason that most of the research was on production.

Although the major efforts of extension workers have been given to production programs through the years, it would not be correct to assume that no attention was given to marketing. This field of work expanded until by 1938 more than a million farmers were assisted in their marketing problems by county and State extension workers. Emphasis has been largely on local needs and, in recent years, has included assistance to cooperatives having membership of more than 2 million farm families.

Educational work in marketing has expanded greatly since passage of the Research and Marketing Act. This work is too new for us to expect revolutionary changes, but a few examples will illustrate progress to date and suggest possibilities for the future. All this work is cooperative with the States.

In Mississippi livestock producers have customarily marketed two-thirds of their cattle in late summer and fall. Cattle sold there in March, April, and May bring an average of 7 cents a pound more than those sold in the fall. But to carry them over the winter economically requires good winter pastures. An educational program stressing better pastures and spring marketing is already showing results. Ten times as many cattle were sold in the spring of 1950 as in the spring of 1949. If only 10 percent of the yearly marketings could be switched from fall to spring, it would mean an increase in returns of more than $6 million a year.

Marketing educational work is directed to city consumers as well as to farmers. These programs have the double purpose of helping consumers choose economical foods for nourishing diets and at the same time helping producers to market foods that are abundant at the time. One method used in many States is to prepare buyers' guides on foods and give them wide dissemination through organizations, press, radio, television, and all other available means.

Consumers who followed extension buying guides in the spring of 1950 saved money by using less expensive cuts of meat, especially pork. They also got some good bargains in apples, cherries, and apricots in areas where these fruits were abundant. In each case the demand created by these educational efforts strengthened the market and gave farmers larger returns.

The future of our educational work is limited only by the rate at which we acquire new knowledge through research and by our own ingenuity and imagination in presenting this new knowledge to the people of the United States. They have demonstrated their faith in research. They have shown over and over again their willingness to accept new ideas and better practices. If our efforts sometimes seem to be failing to get results, it is not the fault of those we serve; it is a challenge to us to do a better job.

AGRICULTURAL HEADLINES -- 1839-1950

(Some of the important events in agricultural research and service in which the USDA or the State agricultural experiment stations have had a part. A few of the dates are approximate.)

1839 - $1,000 authorized for distributing seeds and collecting statistics

1856 - Government establishes plant propagating garden

1859 - Federal Government imports Italian honeybees

1862 - U. S. Department of Agriculture established

1866 - USDA collects data on crops and farm wages

1872 - Colorado potato beetle controlled with paris green

1881 - Plant diseases caused by bacteria
- Kerosene emulsion first practical contact spray for agricultural use

1883 - Food studies reveal adulteration

1885 - Grasshoppers killed with poison baits

1887 - State agricultural experiment stations authorized in all States

1888 - Scientists import beetle to control scale insect on citrus

1889 - Sheep disease traced to worm parasite

1890 - Babcock develops quick, simple test for butterfat

1891 - U. S. to have national forests

1892 - Scientists measure expenditure of energy by placing man in calorimeter
- Livestock industry saved by eradication of pleuropneumonia

1893 - Ticks responsible for spread of Texas fever in cattle

1895 - Value of legume inoculations demonstrated

1896 - USDA publishes tables on food composition
- Many fruits must be cross-pollinated with other varieties

1897 - Vaccine prevents blackleg disease in cattle

1898 - First standards for processed foods established
- Soil classification and mapping begins

1899 - Plants bred to resist disease

1900 -Methods improved for pasteurizing milk

1901 - Relation of housefly to human health pointed out

1903 - Cause of hog cholera discovered
- First wilt-resistant seed flax distributed
- USDA inaugurates farm management studies

1905 - Insects spread plant diseases
- Fight begins to control sheep and cattle scabies

1906 - Meat inspection service protects consumers
- First cow-testing association organized
- Pure food law enacted
- Congress increases funds for State station research
- First county agent appointed

1907 - Research begins on soybeans
- Hog cholera serum used successfully
- Brown rot of peaches controlled with fungicide

1908 - Egyptian cotton grown in U. S.

1909 - Crested wheatgrass new forage crop for Great Plains

1910 - Insecticide Act protects against adulteration and misbranding

1911 - Crop rotations help control nematodes
- One-variety cotton area established
- USDA analyzes organization of farms for economic adjustment

1912 - USDA recommends standards of quality for grain
- Monthly forecasts begin on crop production
- Ladino clover introduced in U. S.
- Co-op marketing research begins

1913 - Depleted ranges restored by deferred grazing
- USDA begins marketing studies
- First home demonstration agent appointed

1914 - Fixation of atmospheric nitrogen for fertilizer
- Official standards established for grading cotton
- Federal-State Cooperative Extension Service begins operation
- "8 to 1" maturity standard established for oranges
- Farmers' special credit needs analyzed

1915 - Vitamin A discovered
- Market news service begins
- Improved shipping containers save millions annually
- Hessian fly controlled by safe planting dates
- Farmers' special insurance needs analyzed

1916 - Calcium arsenate effective against boll weevil
- Cotton Futures Act provides for uniform futures delivery contracts
- Official standards established for grain
- U. S. Warehouse Act promotes orderly marketing
- Congress fixes standards for market containers
- Marketing work begins on Federal-State basis

1917 - Improved terraces developed to control erosion of farm land
- Process for making phthalic anhydride launches U. S. vat-dye industry
- Federal inspection begins with fruit and vegetables
- Federal State cooperation in crop reporting begins

1918 - Barberry eradication begun to control stem rust of wheat
- Bud sports promise improvement in fruits

1919 - Sanitation system controls swine roundworms
- Airplanes used to fight forest fires

1920 - Day length controls flowering and seed production of many plants
- USDA broadcasts market news
- "Farm population" first defined for use in U. S. Census
- Farm leases improved
- Major U. S. land uses inventoried

1921 - Hybrid corn, a commercial success
- Radio used in fighting forest fires
- Carbon tetrachloride controls hookworms in man and animals
- Public stockyards regulated

1922 - Grain futures trading regulated
- Shipping point inspection begun for fruits and vegetables
- Airplanes equipped for dusting cotton
- Vitamin D in cod liver oil prevents rickets in chicks
- Wright's coefficient of inbreeding speeds improvement of livestock
- USDA analyzes supply-and-demand of agricultural commodities
- Farm family living standards measured

1923 - Growers use ethylene to develop natural color of citrus fruit
- Annual agricultural outlook conferences begin
- Relative humidity of air an index to forest fire danger
- New method of farm bookkeeping introduced
- Effects of heredity on growth and fertility of animals demonstrated

1924 - Korean lespedeza introduced
- Vitamin D added to milk by irradiation
- Index numbers established for prices paid and received by farmers
- Wood protected from insect injury by chemical treatments
- Semi-chemical pulping process developed

1925 - Copper and iron combination in feeds saves thousands of baby pigs
- Cure of "alkali" cattle disease saves thousands of dollars in West
- New method developed for kiln drying hardwoods and softwoods
- Commodity situation reports begin

1926 - Cooperative Marketing Act paves way for helping co-ops
- Vitamin A necessary in diets of farm animals
- New sugar beets resist curly top disease

1927 - Advantages of cooking meat at moderate temperature demonstrated
- Steam distillation begins revolution in production of gum naval stores, industry
- USDA recommends quality standards for fruits and vegetables
- 4-H Clubs send representatives to first national camp

1928 - National Farm and Home Hour broadcasts begin
- Experiments show value of forest cover for stable water supply

1929 - Practical field test for pullorum disease reduces heavy losses of poultry
- Last of 6 foot-and-mouth disease outbreaks eradicated in U. S.
- Aerial photographs used in soil mapping
- New seed cotton drier proves practical
- Tobacco Standards Act provides for official grades
- Erosion control studies begin

1930 - Perishable Agricultural Commodities Act suppresses unfair practices
- Weather studies aid crop forecasters
- Science of sampling improves crop reporting
- Mediterranean fruit fly eradicated from Florida
- New methods cut costs of planting forest trees
- Strain 19 vaccine prevents brucellosis in cattle
- First hybrid pine trees produced

1931 - Corn-hog ratio established
- Improved ranges reduce soil erosion in West
- Research shows role of endocrine glands in milk secretion

1932 - "Fixed coppers" kill fungus diseases of vegetables
- Golden Cross Bantam sweet corn resists bacterial wilt
- Disease-resistant Katahdin potato released
- First hybrid hogs produced

1933 - Close inbreeding reduces size, vigor, and reproduction rate in dairy / cattle
- Dusts and sprays of rotenone control Mexican bean beetle
- Diet standards translated into family food plans
- USDA licenses stabilize milk market
- Export Apple and Pear Act protects market for American fruit
- Wet lands in South reclaimed by improved drainage methods
- Price-parity standard adopted
- Control of shipments of fruits and vegetables begins

1934 - Productivity ratings for soil types published
- Rutgers tomato introduced
- Egg quality is determined by inheritance
- Columbia sheep combines efficient wool and meat production
- Chemicals used to thin apple blossoms
- Thatcher wheat resistant to stem rust for hard red spring area
- First fire danger meter to determine potential size of fire job

1935 - New planting equipment for sugar beets saves seed and labor
- Soil fumigation controls nematodes
- Milky disease controls Japanese beetle grubs in lawns
- Reseeding legumes aid erosion control in South
- First successful hybrid chickens produced
- Fertilizer studies show value of side placement
- Price spreads from farm to retail store analyzed
- Stressed-skin principle used in prefabricated house construction
- Nation-wide proved-sire program begins
- Conservation farm plans boost farm income
- Vitamin E discovered
- Pine-gum cleaning continues improvement of gum naval stores production
- Use of fire favors natural reproduction of longleaf pine
- Vitamin K necessary for normal blood clotting power in chicks
- Types of farming mapped for U. S.
- Water supplies forecast by snow measurements
- Modernized market facilities needs analyzed

1936 - Nematode-resistant grape introduced
- Bark beetles identified as carriers of Dutch elm disease fungus
- Soil moisture at seeding time foretells wheat yields
- Radioactive isotopes used in plants and soils investigations
- Vitamin A requirements of dairy cattle established
- Commodity Exchange Administration established
- Concentrated sprays speed forest insect control
- Atlas of American Agriculture published
- Nation-wide survey of "superior germ plasm" in plants and animals
- First comprehensive study of Nation's range resources
- Parshall flume accurately measures irrigation waters
- Input-output studies in agriculture begun

1937 - Wilting method of making grass silage developed
- Cheddar cheese made from pasteurized milk
- Insecticides found effective against European corn borer
- Analysis of forest taxation gives basis for State and local policies
- Nicotinic acid, one of the B-vitamin group, isolated
- Bees resistant to American foulbrood developed
- Tracing bighead disease to poisonous plants aids sheep industry
- Marketing agreements assure minimum prices for milk

1938 - Oil-insecticide treatment controls corn earworm in sweet corn
- Stubble mulch culture conserves soil and water
- Proved-sire method of breeding superior dairy cattle demonstrated
- Phenothiazine removes internal parasites of livestock
- Reseeding crimson clovers developed
- Feeding minerals rich in phosphorus corrects abnormal conditions in cattl
- Reseeding opens wide opportunity for range improvement
- Tetrachloroparabenzoquinone discovered as a superior seed fungicide
- Method of making fiber from casein developed
- By-passing sediment-laden runoff reduces sediment in reservoirs

1939 - First artificial-breeding association for dairy cattle organized
- Inauguration of farmer opinion surveys
- Accurate method of sizing children's clothing developed
- USDA authorized to represent farmers before ICC
- Control methods developed to stop gully erosion
- Resins and coatings made from lactic acid
- Improved gluing techniques foster new laminating industry
- Growth regulators prevent dropping of fruits at harvest
- Protein synthesized from nonprotein nitrogen in stomach of cow
- Relation between vitamin A deficiency and blindness in cattle shown
- "Salt sick" in Florida cattle corrected by feeding copper and iron
- Federal Seed Act regulates commerce in specified seeds
- Vegetative cover reclaims sand dunes and prevents wind erosion
- Barriers to trade in farm products analyzed

1940 - Acid stimulates flow of gum from pine trees
- Production adjustment studies to determine wartime production potentials
- Wilt-resistant alfalfa released
- Combine-type sorghums become mass-production cash crop
- Beltsville Small White turkey introduced
- Erosion control increases crop yields
- Bovine TB reduced to less than half of 1 percent throughout U.S.
- Economic studies of farm technology provide basis of wartime expansion
- First use of parachute fire fighters in regular fire fighting operations

1941 - Cobalt deficiency in cattle recognized
- Women's functional clothes designed
- Liquefied-gas aerosols new method of dispersing insecticides
- Potato storage houses redesigned for greater efficiency
- Effective screwworm remedy developed
- Dairy nutrition guide wins Nation-wide acceptance
- Udders of young calves foretell producing ability
- Cotton Testing Services Act provides for fiber and spinning tests
- Cancer-producing properties of 2-acetaminofluorene discovered

1942 - Wilt-resistant tobacco developed
- Scientists establish safe moisture limits in stored grain
- Lanthionine, new amino acid, isolated
- National and per capita food supply statistics compiled for war use

1943 - Large-scale production of penicillin made possible by research
- Antibiotic streptomycin isolated from soil fungus
- DDT residual insecticide controls livestock, crop, and household pests
- DDT controls typhus, malaria, and other insect-borne diseases
- Airplanes equipped for applying liquid insecticides
- Adequacy of feed supplies measured
- Soaps from inedible animal fats aid synthetic-rubber production
- Costs of producing food nutrients measured

1944 - New peanut sheller adapted to small farms
- Citrus canker eradicated from U. S.
- First hybrid onion introduced
- Plant-growth regulators kill weeds
- Improved procedures developed for controlling shrubs on ranges
- Vitamin A content of Nation's butter supply determined
- Sodium fluoride controls swine roundworms
- Industry given means of recovering fruit-flavor essences
- Improved methods of soybean analysis save millions for Government
- Master Sample provides improved basis of gathering agricultural statistic

1945 - Phony peach disease eradicated from 7 States
- Inauguration of the annual Balance Sheet of Agriculture
- Moisture-fertility-stand balance is essential to high crop yields
- New huller and pick-up machine for tung nuts
- Industrial alcohol made from wood waste
- Hessian-fly-resistant wheat released
- Phosphatase test detects underpasteurization of milk in dairy products
- Commercial production of frozen concentrated orange juice begins
- Comprehensive analysis of postwar prospects for agriculture

1946 - Inauguration of Consumer Preference surveys
- Scientists make home-canned foods safer and better
- Organic phosphorus compounds introduced as insecticides
- Red Sindhi cattle imported for developing heat-tolerant dairy cattle
- Rutin, new drug from buckwheat plants, used to treat weakened blood / vessels
- Research and Marketing Act enacted
- DDT found in milk of sprayed cows and those fed treated crops
- Minnesota No. 1 new meat-type hog breed
- Vigo wheat disease-resistant variety for soft red winter area
- Chemical weed killers used in production of cereal crops
- Hamprace new meat-type hog breed
- Scientists learn how to remove lignin,indigestible ingredient of feeds
- Characteristics of U. S. farms analyzed by size and economic class
- Rate of gain in beef cattle shown to be highly heritable

1947 - New soybean glue used in more than half of U.S. shotgun shells
- Retail training increases sales and reduces losses in fruits, vegetables
- National food supply, 1909-1945, appraised nutritionally
- Cross-breeding experiments with dairy cattle show promise
- Battle begins to eradicate foot-and-mouth disease from Mexico
- Hybrid corn resistant to corn borer released
- USDA "blue prints" terminal market facilities
- New test of cotton maturity aids cotton-textile industry
- Aerial sprays control forest insect pests
- Novel froth-flotation process for cleaning peas adopted by canners
- RMA contracts provide new approach to USDA research and service work
- First permissive consumer standards for fresh fruits and vegetables
- Consumer education started by State and Federal Extension Services

1948 - Filament spun from milk casein used in carburetor air filters
- Industrial production of new textile fiber from corn protein begins
- New synthetic rubber with high heat resistance made from milk sugar
- Chemicals cut cost of weed control in irrigation ditches by 90 percent
- New designs improve bulk drying of grains
- New mechanized sprayers and dusters improve corn borer control
- Plant disease warning service begins in East
- Citrus purees produced commercially
- Farm electrification economics appraised
- Field-cured hay averages 25-percent loss in feed value

1949 - Systemic insecticides promise new approach to insect control
- Combine-type waxy sorghum good substitute for tapioca
- Scientists measure effect of tire design on tractor efficiency
- New lint cleaner removes fine trash from cotton
- Milk a good source of vitamin B_{12}
- Safe substitutes for DDT recommended to dairy farmers
- Synthetic pyrethrum made in laboratory
- Chlordane and toxaphene enable individual farmers to control grasshoppers
- Fungal amylase lowers cost of producing industrial alcohol
- Unknown growth factor for poultry identified as vitamin B_{12}

1950 - Natural enemies of oriental fruit fly established in Hawaii
- Blister rust of white pine under control on 12 million acres
- Outbreak of deadly Asiatic Newcastle poultry disease eradicated
- Reverse-cycle heat pumps installed in Kansas farmhouses
- Parity prices for commodities modernized
- Bactericidal radiation increases egg production 19 percent
- More seed of improved varieties results from Foundation Seed Program
- New vegetable shipping crates reduce losses
- Improved grocery check-out counter developed